U.S. DEPARTMENT OF THE INTERIOR

PROTOTYPE OIL SHALE LEASING PROGRAM

TRACT C-b

QUARTERLY REPORT #2

(Through February 28, 1975)

Submitted to:

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By:

Ashland Oil, Inc.
Atlantic Richfield Company, Operator
Shell Oil Company
The Oil Shale Corporation

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QUARTERLY REPORT #2

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SECTION II D

BIOLOGY

The attached document, a report of Biological Studies prepared by Woodward-Clyde, Biological Consultants, is the result of the second quarter (December, 1974 through February, 1975) of biological baseline activities on Federal Oil Shale Lease Tract, "C-b". Included in the reporting for this quarter are the following studies:

<u>Terrestrial Wildlife Studies</u>

Big Game, Medium-Size Mammals, Small Mammals, Birds, and Microarthropods.

<u>Aquatic Studies</u>

Fish, Benthos, Periphyton, and Water Quality.

<u>Terrestrial Vegetation Studies</u>

Floristic Studies

<u>Dendrochronology and Dendroclimatology</u>

<u>Soils and Soils Productivity Assessment</u>

Project 74-669

SECOND QUARTERLY REPORT: DECEMBER 1974 – FEBRUARY 1975

BIOLOGICAL BASELINE STUDIES
Federal Oil Shale Lease
TRACT C-b

prepared for
Atlantic Richfield Company, Operator

March 1975

WOODWARD-CLYDE CONSULTANTS • Western Region
ENVICON DIVISION • Environmental Consultants

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SUMMARY

Biological baseline studies for Tract C-b and vicinity were begun in August 1974. The purpose of this two-year program is to meet the Federal Oil Shale Lease Environmental Stipulations.

In this task Woodward-Clyde Consultants' biological staff is being assisted by the following:

- Stoecker-Keammerer & Associates (vegetation, medium-sized mammals, and big game movement)
- Ecology Consultants, Inc. (avifauna)
- Dr. Tyler A. Woolley (soil arthropods)
- Mr. Michael Glenn (dendrochronology and dendroclimatology)
- Dr. James Ward (limnology).

Federal Oil Shale Lease Tract C-b is in Rio Blanco County approximately 18 miles west of Rio Blanco, Colorado, and south of Piceance Creek in the Piceance Creek Basin. The study area includes this tract (about 5100 acres) and an additional area covering at least 1 mile beyond the tract. The biological investigations have been divided into four general areas:

- Terrestrial Wildlife Studies
- Aquatic Studies
- Terrestrial Vegetation Studies
- Dendrochronology and Dendroclimatology.

This second quarterly report represents the work carried out from November 1974 to February 1975 and presents additional field data, methodology, and a continuation of preliminary discussions of the findings.

Where possible, these preliminary evaluations have included data from the first quarter's results. As the studies progress, significant or important aspects of the ecological communities will be pointed out in terms of population trends, species relationships, interactions, and unique observations. A summary of this quarter's studies follows.

TERRESTRIAL WILDLIFE STUDIES

The wildlife program during this quarter included studies of big game, medium-sized mammals, small mammals, and birds. Study areas for these animal groups have been designated and represented on figures in the First Quarterly Report.

The importance of Tract C-b to big game from November 1974 to February 1975 was evaluated through monthly air reconnaissance flights, track counts, and evening road counts.

In the early fall the deer were utilizing the hay meadows along Piceance and Willow creeks quite heavily. In December and January, however, the deer had largely abandoned the meadows and were found widely dispersed throughout the pinyon-juniper woodland. Browsing occurred mainly in the chained areas and in the woodland. There was little evidence of feeding in the valleys or on grassy south-facing slopes.

During February, deer began to utilize the south-facing slopes, while they appeared in fewer numbers and were more localized in the pinyon-juniper. The shift in habitat usage is probably related to snow conditions, particularly the freeze-thaw cycles which cause drifts to become crusted. Movement of the deer is inhibited by these conditions, and access to food is difficult where snow has accumulated. The south-facing slopes, on the other hand, are free of snow and consequently are heavily utilized. January observations show that deer preferred mountain mahogany, serviceberry, and bitterbrush, in that order.

Many medium-sized mammals are inactive during winter, but track counts were used to monitor the active ones. Very few species were noted in the track quadrats this winter, and the frequencies were generally low. Deer tracks were the most abundant in the transects, with cottontail and jackrabbit tracks next in number. (Even though deer are considered big game, their tracks were counted in the medium-sized mammal transects whenever they were found.) The low numbers may indicate a cyclic low in rabbit and hare populations. In many areas of the mountain shrub community, however, tracks and browsing evidence of the jackrabbit were abundant. The shrubs utilized were snowberry, Gambel's oak, and mountain mahogany.

Of the 12 small mammal species identified during the first quarter, only 2 were observed this winter. These included the deer mouse (*Peromyscus maniculatus*) and the montane vole (*Microtus montanus*). Most small mammals hibernate or become inactive for extended periods in winter. These include the chipmunks, ground squirrels, and pocket mice. Others, such as the wood rats, store food and reduce their daily activity. Satellite grids were activated to access the relative activity and abundance of these small mammals. The deer mouse was the more abundant of the two species observed. Voles burrow under the snow, and their activity and abundance as revealed in trap results may not be representative of their winter population. In December, before snow covered the valley floors, the voles were very active and abundant above the ground.

The avifauna census conducted in January provided absolute densities of songbirds, relative abundances of all birds and waterfowl, and additional raptor nest locations. Of the 57 species recorded on the transects during fall, only 24 were found in the winter census. An additional 12 species were encountered for the first time.

Twenty wintering bird species were observed on the tract. The six most abundant species were the horned lark, American robin, gray-crowned rosy finch, black rosy finch, brown-capped rosy finch, and the tree sparrow.

The pinyon jay, mountain chickadee, red-breasted nuthatch, and Townsend's solitaire were typical of the pinyon-juniper woodland. The Piceance Creek area was dominated by horned larks and American robins. Mountain chickadees, dark-eyed juncos, and gray-headed juncos were distributed throughout the mountain brush community. The mixed rabbitbrush-sagebrush area of the West Fork of Stewart Gulch accounted for the American robin, northern shrike, and the tree sparrow. Mallard, green-winged teal, American widgeon, common goldeneye, and bufflehead were the dominant waterfowl.

The rough-legged hawk was the most abundant raptorial bird encountered. The golden eagle, American kestrel, great horned owl, and snowy owl were also observed. Additional raptor nests were located, and pellets and castings were collected for laboratory analysis of prey species.

An important observation was documented by Dr. Robert Stoecker on February 27, 1975. A prairie falcon (*Falco mexicanus*) was observed off Tract C-b near Piceance Creek between Sorghum and Cottonwood gulches. The falcon is a nationally threatened species.

AQUATIC STUDIES

The aquatic studies for this quarter included fish, benthos, periphyton, and water quality. Locations of sampling stations, and their descriptions, are included in the First Quarterly Report.

Fish

Fish collected during January represented the same species collected on previous surveys. The mountain suckers were the most abundant fish, with brook trout second. Mountain suckers were captured in Piceance Creek, Willow Creek, and Stewart Creek, while brook trout were concentrated mainly in Stewart Creek and the channel that drains lower Stewart Lake.

Length-weight tables of captured fish were prepared to examine the relative structure of the fish populations. Most suckers were in the length range of 120-160 mm and probably represent the dominant year class in the population. Mean weights for the dominant year class range from 16 to 50 mg.

Few brook trout were collected in September or November, but January captures show that the dominant year class is in the size range 100-140 mm.

In terms of fish species, most stations along the Piceance Creek are similar. The White River stations, however, are not similar in species to the others. This is to be expected because the White River has a different environment (river) than that of the Piceance (small stream).

Benthos

Benthic macroinvertebrate samples in the study area to date have yielded annelids, arthropods, and molluscs. The arthropods, especially insects, were the most numerous. Benthic samples during this quarter were analyzed for number of individuals, number of species, biomass, species diversity, and for similarities between samples.

Generally, shifts in biomass and species diversity were attributed to seasonal changes. These changes are natural and reflect both quantitative and qualitative changes in the fauna over time. Any significant differences between stations were attributed to differences in habitat. Analysis of sample similarities indicated that many of the stations have roughly the same species composition, and that triplicate samples are generally adequate to describe the bottom fauna. Species diversity indices remained relatively constant over the entire study period and it is concluded that the benthic community has been relatively stable since September 1974.

Periphyton

The term "periphyton" is used to designate the assemblage of microscopic plants and invertebrates that cover solid substrata in aquatic environments.

Stations on Willow Creek and on the White River generally supported the greatest number of genera of periphytic algae. The number of genera did not appear to vary greatly over time for the Piceance Creek stations. Station P-7 exhibited the lowest number of genera.

Biomass estimates show that stations P-1, P-3, and P-5 had the greatest biomass, while station S-1 had the lowest. The range of biomass was 0.62 to 84.4 gm/m^2. Willow Creek and the White River supported a similar biomass, while Stewart Creek exhibited the lowest standing crop. Seasonal changes in biomass were evident. As winter approached, 8 of 12 stations showed a decrease in biomass.

Water Quality

Water samples were analyzed for common minerals and nutrients, dissolved oxygen, pH, specific conductance, coliform counts, and pathogens. The presence of fecal coliforms and streptococci indicate fecal pollution. The main source of these fecal coliforms and fecal streptococci is the cattle grazing along the basin. No pathogenic bacteria were identified in the water samples.

TERRESTRIAL VEGETATION STUDIES

No field surveys were conducted during the second quarter. The primary efforts in this quarter involved work on the vegetation map and preparation of an annotated flora for Tract C-b. An important feature of the compositional details of vegetation is floristics. Stated simply, floristics is the study of the plant species in an area, the distribution of these species, and their relative abundance. This information is basic to the remaining studies of vegetation structure and function. The annotated flora of those species collected to date presents family, scientific and common names, statement of abundance, community affinity or habitat, life form, and geographical distributions.

Using Raunkiaer's classification system of life forms, it is found that the Tract C-b flora is composed mostly of hemicryptophytes (perennating bud in soil surface) and phanerophytes (perennating bud at least 0.25 meter above soil surface). The percentage distribution of different life forms on the tract suggests a shrubland flora with a high percentage of herbaceous perennials.

DENDROCHRONOLOGY AND DENDROCLIMATOLOGY

The dendroclimatic analysis was completed at the end of this quarter and will be reported on in the next quarterly report. Chronologies have been prepared, and the correlation of growth increments to precipitation has been accomplished. This analysis will give an indication of major climatic trends.

SOILS AND PRODUCTIVITY ASSESSMENT

Soil samples were collected from the tract in January and are being used for vegetation growth experiments in a greenhouse. The data accumulated from these experiments will be statistically analyzed to determine the productivity of the various soil types. It is anticipated that this program will be completed soon and will be reported on in the next quarterly report.

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Pre-trial Wildlife Studies

BIG GAME

Methodology

Three methods were used to describe patterns of deer movement from December 1974 through February 1975:

- monthly air reconnaissance of Tract C-b and a surrounding zone (Figures I-1 and I-2)
- track counts (an adjunct to the study designed primarily to monitor medium-sized mammals)
- evening road counts.

These methods are quantitative and repeatable. In addition, field observations were conducted to facilitate interpretation of data.

Air reconnaissance flights were conducted on December 17, January 29, and February 28. Flights perpendicular to the drainages of Piceance Creek (generally an east-west direction) at about 500 feet were conducted to rank the abundance of deer tracks (none, low, medium, high, or very high for ridge tops, slopes, and valleys). A tape recorder was used to record these data as well as information concerning major directions of deer movements, snowdrift patterns, locations of eagles, coyotes, and other animals. Eight transects were flown, providing coverage for Tract C-b and a large surrounding zone (Figures I-1 and I-2). Methods used for track counts were

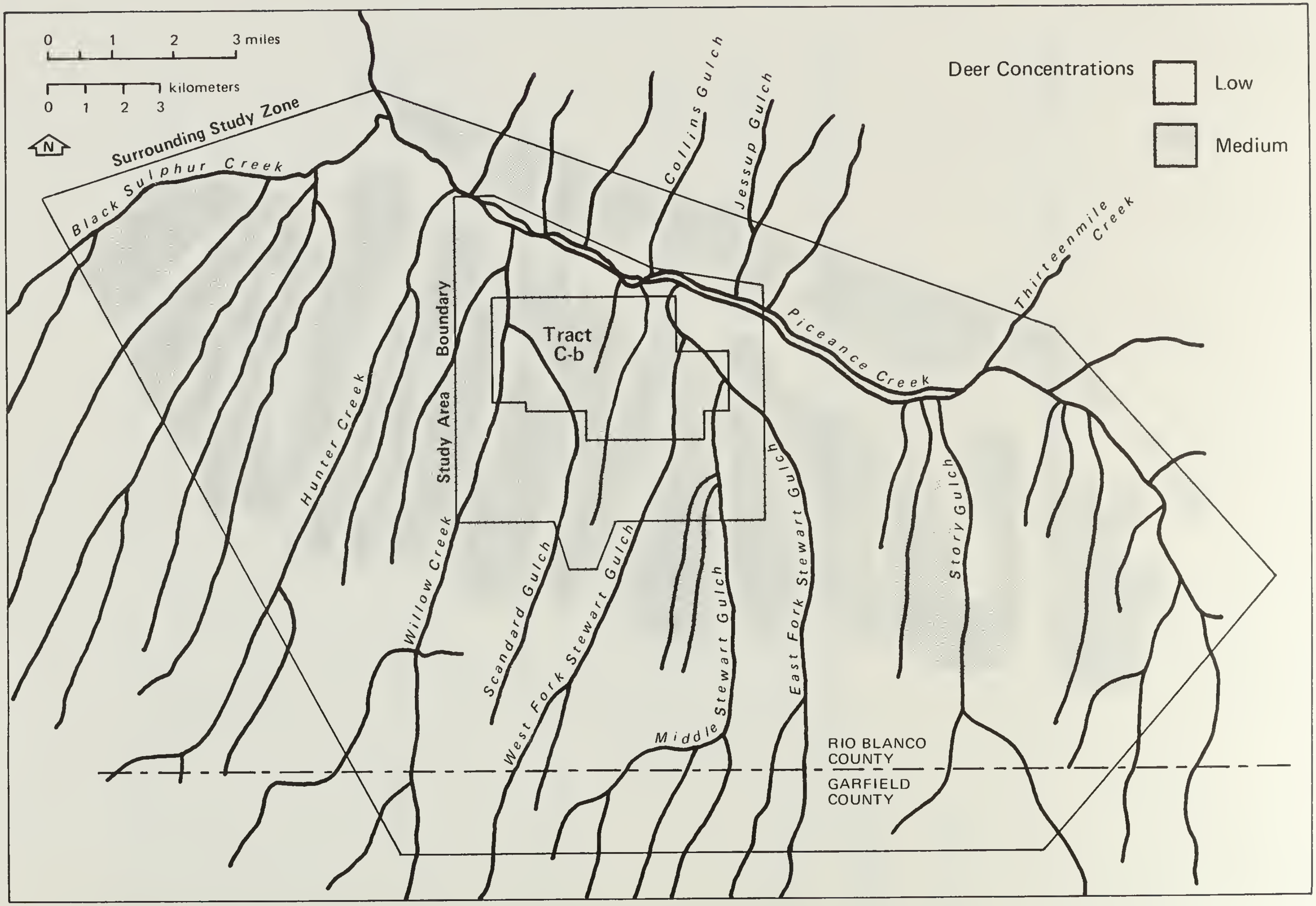

Figure I-1. DISTRIBUTION OF DEER DURING DECEMBER 1974 AND JANUARY 1975

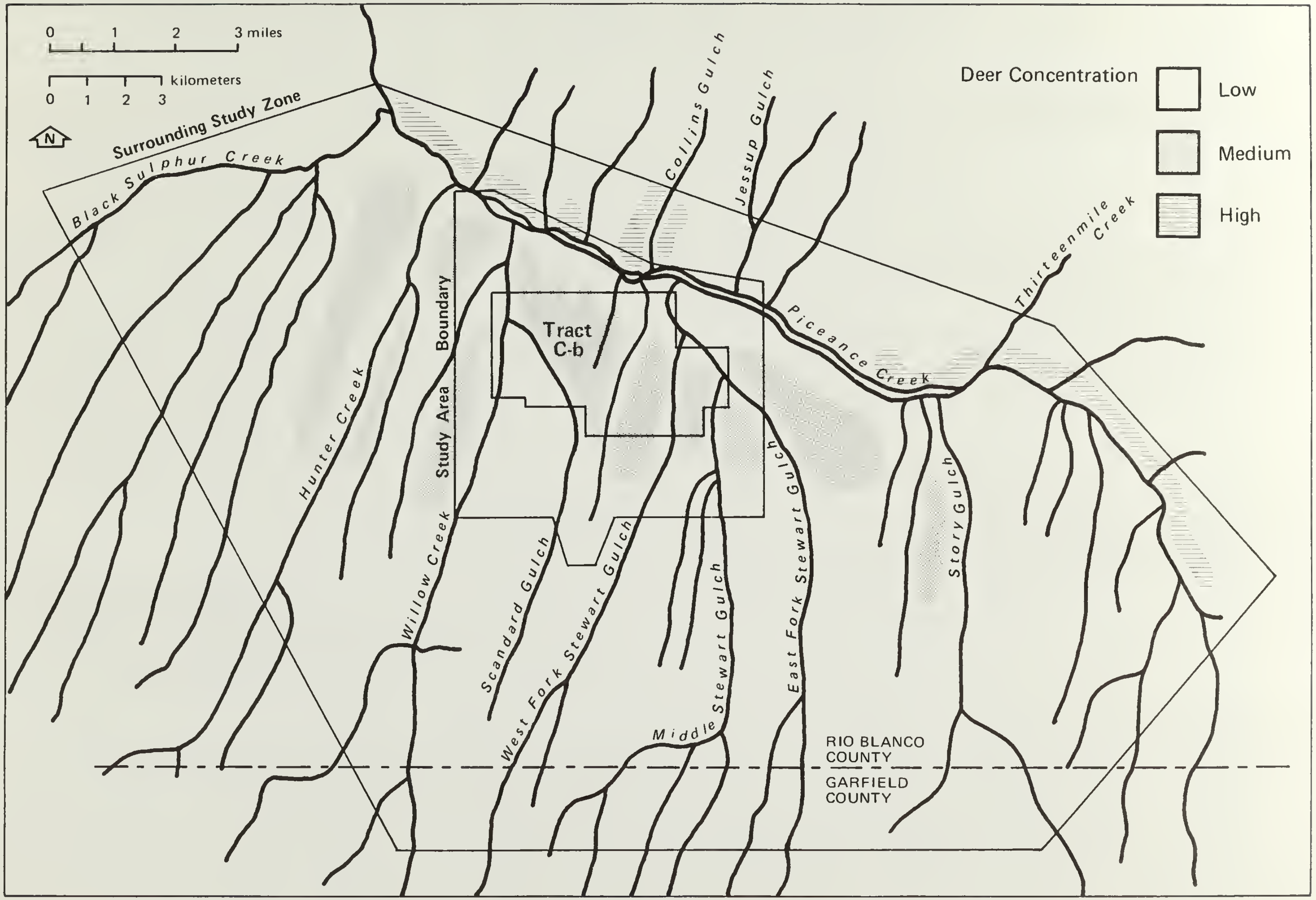

Figure I-2. DISTRIBUTION OF DEER DURING LATE FEBRUARY 1975

explained in the First Quarterly Report. More transects were covered during this quarter, since sampling on fresh snow in the winter can be accomplished more quickly than on a dry substrate.

Evening road counts were performed in the same manner as in the first quarter, except that on February 27 a 21-mile road count was performed in order to better evaluate large deer concentrations noted on the south-facing slopes near Piceance Creek.

Results and Discussion

Movements of deer during the preceding quarter (September, October, November) were characterized by a small but perceptible influx of deer onto Tract C-b during September (probably from higher elevations, mainly to the south). In October and November a marked influx of deer had occurred, with major concentrations conspicuous in the alfalfa meadows along Piceance Creek immediately north of Tract C-b. The deer bedded during the day primarily on the pinyon-juniper ridges near the north boundary of Tract C-b. These deer were not forced from the high country by inclement weather during this fall influx but were apparently attracted to the lower meadow by the alfalfa. It is unclear, however, why they concentrated in the alfalfa meadows near Tract C-b and were virtually absent from other alfalfa meadows in the vicinity.

In December 1974 and January 1975 the deer had largely abandoned the alfalfa meadows and were more commonly found widely dispersed throughout the pinyon-juniper woodland. Few deer were observed at higher elevations (in mixed mountain shrub) and at lower elevations (in agricultural meadows) in the sage valleys. Bedding grounds were mainly in the woodland, and feeding occurred there as well as in chained areas. Little evidence was found of feeding activity in the lower irrigated or nonirrigated valleys (e.g., hay meadows, sagebrush) or on grassy south-facing slopes. This same distributional pattern was borne out by the deer-count data (Table I-1) as well as by the bimonthly track counts

(Table I-2). Snow completely covered the ground on several occasions during these months, but it generally was less than a foot deep and there was little drifting or crusting.

In February 1975 there was a marked change in the distributional pattern of deer. South-facing slopes along Piceance Creek were utilized heavily for the first time (Figure I-2 and Table I-1). Deer continued to be present in the pinyon-juniper areas, but in fewer numbers and seemingly in more localized areas. Whether localized areas were in fact being selected by the deer (perhaps because of some important habitat feature) is not clear. This impression of more localized usage could be due merely to a lower density of deer in the pinyon-juniper areas compared to their density in December and January.

The February shift in habitat usage by the deer in the Tract C-b area was undoubtedly related to snow conditions. Snow during late February was not overly deep (generally 6 to 12 inches, with drifts of 2 to 3 feet), but many freeze-thaw cycles over a 2-week period caused drifts to become crusted, particularly on north-facing slopes. In contrast, south-facing slopes melted free. While the quality of forage on these south-facing slopes is inferior to that of the typical understory within the pinyon-juniper woodland and in the chained areas, crusted snow made access to food as well as movement difficult over wide areas, and probably impossible in areas having the deepest drifts.

During the field visit of January 14-17, 1975, general qualitative observations of browse utilization by deer were made at several locations on Tract C-b. These locations were chosen to represent an array of vegetative types that included the mountain shrub, pinyon-juniper woodland, chained pinyon-juniper, and valley sagebrush associations.

Table I-1. DEER ROAD COUNTS NEAR TRACT C-b

Location	Number of Deer Observed, by Date: 12/11/74	12/12/74	1/18/75	2/27/75	
Lower Willow Creek[a]	(M)	(M)	(M)	(M)	(S)
mile					
1	20	5	0	—*	—
2	22	11	0	—	—
Piceance Creek[b]	(M)	(M)	(M)	(M)	(S)
mile					
1	0	0	3	0	3
2	26	13	6	0	0
3	10	7	0	6	0
4	0	0	0	0	8
5	0	9	0	0	0
6	0	0	0	0	3
7	0	0	0	0	0
8	0	0	0	0	0
9	—	—	—	0	0
10	—	—	—	0	0
11	—	—	—	0	0
12	—	—	—	9	0
13	—	—	—	0	0
14	—	—	—	0	1
15	—	—	—	0	6
16	—	—	—	10	5
17	—	—	—	0	30
18	—	—	—	0	37
19	—	—	—	0	15
20	—	—	—	0	8
21	—	—	—	0	3

Notes: Road counts were conducted in the evening.

[a]From Scandard Gulch to Piceance Creek.

[b]From Rock School toward Rio Blanco.

(M) = Deer observed in meadows.

(S) = Deer observed on south-facing slopes.

*Blanks indicate that road counts were not conducted.

Table I-2. PERCENT FREQUENCY[a] OF TRACKS FROM COUNTS CONDUCTED DECEMBER 14, 1974, AND FEBRUARY 26, 1975

Habitat Type	No. of Quadrats		Deer		Coyote		Cottontail		Other	
	Dec.	Feb.	Dec.	Feb.	Dec.	Feb.	Dec.	Feb.	Dec.	Feb.
Pinyon-juniper	140	60	27	58	0	0	3.6	0	0	1.7[b]
Chained pinyon-juniper	100	40	6	3.5	3	0	7	5	0	0
Upper sagebrush valleys	100	—[c]	5	—	15	—	6	—	0	—
Mixed mountain shrub	40	—[c]	0	—	0	—	0	—	0	—
Lower valleys and agricultural meadows	100	80	0	38	0	7.5	3	3.8	0	2.5[d]

[a] $\text{Percent frequency} = \frac{\text{number of quadrats with tracks}}{\text{total number of quadrats}}$

[b] Jackrabbit

[c] Snow conditions did not permit sampling.

[d] House cat

Although a variety of shrubs had been browsed, certain species were definitely preferred by the deer. The shrubs most commonly browsed, listed in decreasing order of preference, were mountain mahogany (*Cercocarpus montanus*), serviceberry (*Amelanchier alnifolia*), bitterbrush (*Purshia tridentata*), and big sagebrush (*Artemesia tridentata*). Browse utilization data to be collected in the spring at established deer transects will serve to clarify qualitative information gathered in the winter.

MEDIUM-SIZED MAMMALS

Distribution and Abundance

Many medium-sized mammals are inactive during winter (e.g., marmots, skunks, raccoons). Those which are active and known to be present in the Tract C-b area include cottontails, porcupines, jackrabbits, weasels (of several species), and coyotes and bobcats (sometimes included under the category of large predators). The track count method employed in this study monitors these species as well as deer, and would also permit identification of foxes, grouse, elk, mountain lions, and other uncommon species, should they be present.

Results of track count data for this quarter (Table I-2) show surprisingly few species, with generally low frequencies for cottontails and high frequencies for deer. In two habitats the frequency of coyote tracks is also high. The most important conclusion from the track count data is the indication of low population levels, particularly for cottontails, jackrabbits, and weasels. These species could well increase in number in the future. All are subject to periodic fluctuations in density and may now be at cyclic lows. There is little doubt that this is true for cottontails.

General observations in January, away from track-count transects, revealed few tracks of medium-sized mammals. These observations agree with results of track-count data at established transects. However, in many areas where the mountain shrub community on Tract C-b is well developed, heavy browsing and numerous tracks of the white-tailed jackrabbit (*Lepus townsendii*), were observed. The shrub most heavily browsed was snowberry (*Symphoricarpos oreophilus*). Also browsed by the white-tailed jackrabbit were Gambel's oak (*Quercus gambeli*) and mountain mahogany (*Cercocarpus montanus*). White-tailed jackrabbits feed primarily on grasses and forbs during spring, summer, and fall, but are known to switch to a greater amount of shrub material in the winter (Lechleitner, 1969).

Numerous porcupine trails were observed in the snow, especially in and around the pinyon-juniper woodland on the ridgetop overlooking the West Fork of Stewart Gulch. In several areas, fresh signs of stripped bark were seen on the pinyon tree trunks and branches.

SMALL MAMMALS

In the first quarter, twelve species of small mammals were trapped in the study area. Of these species, only the least chipmunk (*Eutamius minimus*), Colorado chipmunk (*Eutamius quadrivittatus*), deer mouse (*Peromyscus maniculatus*), bushy-tailed wood rat (*Neotoma cinerea*), and montane vole (*Microtus montanus*) were present in sufficient numbers to allow quantitative analysis. On the basis of their population size, these species were subsequently termed important members of the small-mammal community.

In order to assess the relative abundance and activity of the important small mammals during the winter, the satellite trapping grids (Figure I-1 of the First Quarterly Report) were activated in January 1975. The quantitative trapping grids (sites 1 and 2) were not activated for two reasons: (1) to avoid deaths of trapped animals in freezing weather, and (2) the relative inactivity of small mammals in winter.

In addition to trapping at satellite grids, general observations were made of small-mammal tracks. The deer mouse (Peromyscus maniculatus) was the most abundant small mammal during winter months, as determined by trapping at satellite grids (Table I-3). Although the number captured in live-traps appears to be relatively small, numerous sets of tracks were observed on the snow, indicating a somewhat higher level of activity than was apparently indicated by trapping. Deer mice do not hibernate, and in winter they actively search for food both above and beneath the snow (Sealander, 1951; Fuller et al., 1969; Lechleitner, 1969).

Only one montane vole (Microtus montanus) was captured during the January trapping period. The abundance of voles and their level of activity in winter was somewhat higher than indicated by live-trapping, since they make runways and burrows beneath the snowpack. Investigation of these runways indicated the presence of a larger number of active voles than was apparent from trapping data.

Very few vole tracks were noted on the snowpack in January, which suggests that the voles spent relatively little time foraging on top of the snowpack. The voles' reduced surface exposure may thus result in a decrease of predation by raptorial birds. In December, however, before the snowpack became established on the valley floors of Willow Creek and Piceance Creek, voles were active during the day and were fully exposed to potential predators. Two trap lines of 20 traps per line were set on December 13 and 14; one was located near Piceance Creek and the other near Willow Creek. These traps were used to indicate which species were present. Ten voles were captured during this period. Two bird species, the sparrow hawk (Falco sparverius) and the common raven (Corvus corvax), were observed taking voles.

The absence of the least chipmunk and the Colorado chipmunk in satellite grid trap lines was expected. Activity of the two species is severely restricted during unfavorable weather. Lechleitner (1969) states that the two species do not truly hibernate, but during colder periods of

Table I-3. TRAP DATA FOR SMALL-MAMMAL SATELLITE GRIDS, TRACT C-b (January 14-16, 1975)

SPECIES		SATELLITES					
		#1 50 Traps 2 Nights		#2 25 Traps 1 Night		#3 50 Traps 2 Nights	
Scientific Name	Common Name	Total Capt.	% Trap Success	Total Capt.	% Trap Success	Total Capt.	% Trap Success
RODENTIA							
Peromyscus maniculatus	deer mouse	5	5	---	---	---	---
Microtus montanus	montane vole	1	1	---	---	---	---
TOTAL		6	6	0	0	0	0

	Location	Habitat Type
#1	Willow Creek	Riparian/Willow-Alfalfa
#2	Piceance Creek	Riparian/Willow-Alfalfa
#3	Near Study Plot 1	Chained Pinyon-Juniper/Mountain Shrub

the winter individuals may stay in their burrows for extended periods, probably utilizing foods gathered during more favorable times. None of these animals was trapped, and no tracks were observed at any site during the January field visit. Similarly, no activity was noted for the bushy-tailed wood rat, although the species does not hibernate. Their habit of storing food will see them through inclement weather of short duration.

BIRDS

The third series of censuses of bird communities on Tract C-b took place January 21, 22, and 23, 1975. The major objective was to obtain information on the birds residing in and utilizing various tract habitats in winter. Both qualitative and quantitative data were gathered and analyzed in a manner consistent with the previous field studies, reported in the First Quarterly Report.

During January, censusing was done using Emlen strip procedures (Emlen, 1971) within the eight standard transects (Table I-1, Figure I-1, First Quarterly Report). Data from these censuses were used to provide estimates of absolute density of songbird species utilizing habitats on the tract. Additionally, qualitative surveys throughout the tract were used to determine the percent of relative abundance of conspicuous birds in all possible habitats. Vacant raptor nests encountered were recorded, photographed, examined, and plotted on field maps. Pellets and castings at nest sites were collected to define predator-prey relationships on Tract C-b.

Results of Strip Census

Transect 1 (Collins Gulch). Five species were found foraging through this transect. Table I-4 presents the density calculated for January. The common flicker and Townsend's solitaire utilized the sparse covering of pinyon-juniper on the western portion of the route, while an

Table I-4. ABSOLUTE DENSITIES OF BIRD SPECIES AT TRACT C-b, TRANSECTS 1 AND 2, IN JANUARY 1975[a]

	TRANSECT 1					TRANSECT 2			
Species	Method of Estimation[b]	Number Observed	Density[c]	% Rel. Density[d]	Species	Method of Estimation	Number Observed	Density	% Rel. Density
Common flicker	A	1	5	0.5	Mallard	A	10	51	2.7
Townsend's solitaire	A	2	10	0.9	Green-winged teal	A	4	21	1.1
Gray-crowned rosy finch	A	142	728	67.3	Wilson snipe	B	3	246	13.1
Black rosy finch	A	49	251	23.2	Horned lark	A	55	940	49.9
Brown-capped rosy finch	A	17	87	8.1	American robin	A	42	215	11.4
					Tree sparrow	B	19	287	15.3
					Song sparrow	B	6	123	6.5
TOTALS		211	1081	100.0			139	1883	100.0

[a] Computed from Emlen Strip Census Conducted January 22, 1975.

[b] See Methodology section of Terrestrial Wildlife Studies of the First Quarterly Report for a description of the calculations of density indicated by A and B.

[c] Density in birds/km^2 of appropriate habitat.

[d] Percentage Relative Density was calculated as:

$$\% \text{ Relative Density} = \frac{\text{Density of Species A}}{\Sigma \text{ Density of All Species}} \times 100.$$

intermixed flock of gray-crowned, black, and brown-capped rosy finches exploited seeds from dried plants protruding from the snow along the north-south highway bordering the route.

Transect 2 (Oldland Ranch/Piceance Creek). The species observed on this route represented those expected to inhabit semi-riparian habitats of this region during mid-winter (Table I-4). Of the 12 species observed on this route during the fall period, only the mallard, green-winged teal, American robin, and song sparrow were present during the winter census. Wilson snipe were flushed along Piceance Creek, while horned larks, American robins, and tree sparrows foraged among domestic cattle in the pastures. The stream was responsible for the presence of mallards and green-winged teal; during qualitative observations, mallards, green-winged teal, and American wigeons were seen utilizing it.

Transect 3 (West Fork of Stewart Gulch). The variety of birds occupying this route were those species expected as winter residents in the sagebrush-rabbitbrush and the pinyon-juniper cover on the sandstone slopes bordering the transect. Of the three species recorded, the tree sparrow was the most abundant in the sagebrush-rabbitbrush bottom, while American robins frequented the adjacent slopes. Northern shrikes were associated with the pine snags and fence posts that dot the transect (Table I-5). Qualitative count surveys along the northern boundary documented the presence of Wilson snipes, American robins, and song sparrows.

Transect 4 (Mammal Plot No. 2). Species diversity and density were low in this homogeneous transect of mixed pinyon pine and juniper. Table I-5 tallies species composition and relative density values for the transect. The mountain chickadee and red-breasted nuthatch together accounted for 72 percent of the relative density of this avian community. Townsend's solitaire, which contributed 67.0 percent (mid-fall) and 60.0 percent (late fall) relative density during the migration season, accounted for only 4.0 percent of the total relative density during the winter sample. The pinyon jays, plain titmouse, and white-breasted nuthatch accounted for the remaining species.

Table I-5. ABSOLUTE DENSITIES OF BIRD SPECIES AT TRACT C-b, TRANSECTS 3 AND 4, IN JANUARY 1975*

	TRANSECT 3					TRANSECT 4			
Species	Method of Estimation	Number Observed	Density	% Rel. Density	Species	Method of Estimation	Number Observed	Density	% Rel. Density
American robin	A	15	77	28.9	Pinyon jay	B	12	103	12.3
Northern shrike	A	3	15	5.7	Townsend's solitaire	B	3	31	3.6
Tree sparrow	B	17	174	65.4	Mountain chickadee	B	7	256	30.4
					Plain titmouse	B	3	62	7.4
					White-breasted nuthatch	B	2	41	4.9
					Red-breasted nuthatch	B	17	349	41.4
TOTALS		35	266	100.0			44	842	100.1

*Computed from Emlen Strip Census conducted January 21 and 23, 1975.

See Table I-4 for a description of Methods of Estimation, Density, and Percentage Relative Density.

Transect 5 (Middle of Sorghum Gulch). Of the four species recorded in this sparse stand of pinyon-juniper, the pinyon jay accounted for approximately 80 percent of the total relative density during January. This jay, a highly gregarious species, flocks and forages in large numbers throughout the fall, winter, and early spring. It disbands into small groups as pairing occurs with the approach of the nesting season (Balda and Bateman, 1974). The two junco species (dark-eyed and gray-headed) and the Townsend's solitaire were found, as expected, utilizing the woodland for foraging and cover (Table I-6).

Transect 6 (Mammal Plot No. 1). No birds were heard or observed within the transect strip through this chained pinyon-juniper community during the winter census. High winds which blow across this exposed habitat and the accumulation of heavy snows may affect bird utilization of this area. Qualitative observations on this transect and on other chained areas during the field period indicated that birds were simply not using this habitat. No species were encountered in any chained plot.

Transect 7 (Vegetation Plot 3). No birds were found in this upland sagebrush habitat during the January census. Species expected to utilize this route occasionally through the winter are easily missed during single observation periods, for they are generally present as flocks which continually move from habitat to habitat.

Transect 8 (Willow Creek). The dark-eyed (slate-colored and Oregon) and gray-headed juncos dominated this habitat by contributing more than 67 percent of the total avian density in the mountain brush community. Two thrush species, the American robin and Townsend's solitaire, tended to perch in the tops of pinyon pines in a portion of the censused plot. Although the mountain chickadee contributed substantially to estimates of relative abundance, density estimates of this chickadee were low. The composition of mixed chickadee and junco flocks was supplemented by the plain titmouse. Table I-6 presents results of the mid-winter census at Transect 8.

Table I-6. ABSOLUTE DENSITIES OF BIRD SPECIES AT TRACT C-b, TRANSECTS 5 AND 8, IN JANUARY 1975*

	TRANSECT 5					TRANSECT 8			
Species	Method of Estimation	Number Observed	Density	% Rel. Density	Species	Method of Estimation	Number Observed	Density	% Rel. Density
Pinyon jay	B	67	625	79.2	American robin	A	3	15	1.1
Townsend's solitaire	B	4	31	3.9	Townsend's solitaire	A	3	15	1.1
Dark-eyed (slate-colored) junco	B	1	82	10.4	Mountain chickadee	B	7	248	18.4
Gray-headed junco	B	5	51	6.5	Plain titmouse	B	2	164	12.3
					Dark-eyed (slate-colored) junco	B	3	246	18.3
					Dark-eyed (Oregon) junco	B	4	247	18.3
					Gray-headed junco	B	10	410	30.5
TOTALS		77	789	100.0			32	1345	100.0

*Computed from Emlen Strip Census conducted January 21 and 23, 1975.

See Table I-4 for a description of Methods of Estimation, Density and Percentage Relative Density.

Qualitative Count Surveys

Results of qualitative count surveys are presented in Table I-7. Qualitative survey values were influenced by tendencies of many wintering species to form flocks which drift from habitat to habitat. Common flocking species which showed high relative abundances included the mallard (8.4 percent), pinyon jay (8.9 percent), American robin (49.1 percent), and tree sparrow (7.3 percent). Species which did not form large flocks but which accounted for a substantial portion of overall relative abundance included the rough-legged hawk (3.7 percent), black-billed magpies, and ravens; the latter two represented a combined relative abundance of 2.5 percent. Magpies and ravens were observed primarily feeding on deer carcasses found as road-kills throughout the region. Overall numbers of birds tallied during the qualitative counts were lower than numbers found during fall, but this is expected during winter in this region. Figure I-3 compares results obtained during the fall migration period and the winter season.

Most of the remaining species observed during January were non-flocking winter residents. Species encountered during the qualitative inventory that can be considered unusual for the winter season are discussed in the Species Listing subsection.

Upland Game Birds

Very little additional information on gamebirds was gathered during this field sampling period. As discussed in the First Quarterly Report, information on the seasonal abundance and habitation of the tract by game birds cannot be speculated on from fall and winter surveys. Most information on these birds will come from Emlen transects and qualitative count surveys conducted during the breeding season.

Table I-7. RESULTS OF QUALITATIVE COUNT SURVEYS AT TRACT C-b, JANUARY 21-23, 1975

Species	Total Individuals Observed	% Relative Abundance*
Mallard	87	8.4
Green-winged teal	2	<1.0
American wigeon	13	1.2
Rough-legged hawk	38	3.7
Golden eagle	8	<1.0
American kestrel	1	<1.0
Wilson snipe	21	2.0
Great horned owl	2	<1.0
Snowy owl	2	<1.0
Downy woodpecker	1	<1.0
Horned lark	123	12.0
Steller's jay	9	<1.0
Pinyon jay	92	8.9
Black-billed magpie	9	<1.0
Common raven	18	1.7
Clark's nutcracker	3	<1.0
Black-capped chickadee	7	<1.0
American robin	503	49.1
Townsend's solitaire	4	<1.0
Northern shrike	3	<1.0
Tree sparrow	75	7.3
Song sparrow	3	<1.0
TOTAL	1025	100.0

*Percentage Relative Abundance was calculated as:

$$\% \text{ Relative Abundance} = \frac{\text{Number of Species A}}{\text{Sum of all Species}} \times 100$$

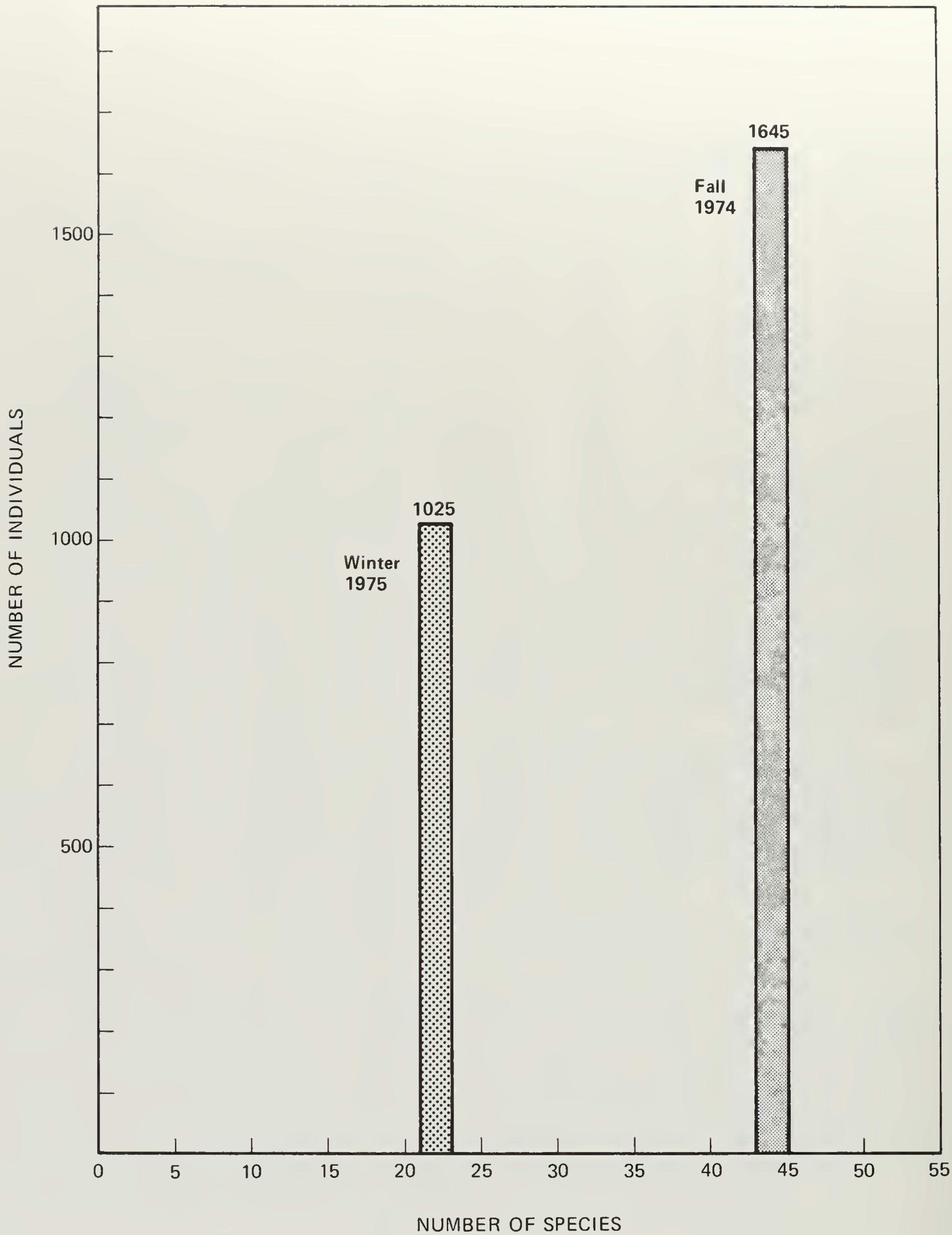

Figure I-3. TOTAL BIRD SPECIES AND NUMBERS ENCOUNTERED DURING QUALITATIVE COUNT SURVEYS CONDUCTED FALL 1974 AND WINTER 1974-75

Waterfowl

Results from the winter censuses at both the Walter Oldland pond and the P-L Ranch pond demonstrated relatively heavy usage of the area by eight waterfowl species. Total waterfowl diversity was numerically dominated by the mallard (44.7 percent relative abundance), green-winged teal (27.1 percent), American wigeon (7.1 percent), common goldeneye (8.5 percent), and bufflehead (8.5 percent), while the gadwall, Barrow's goldeneye, and red-breasted merganser contributed the remaining 4.1 percent (Table I-8). Waterfowl utilization in bird-use days for both impoundments is presented in Tables I-9 and I-10. Although fall samples indicated use of only the P-L Ranch pond, during January both impoundments were used by ducks. The close proximity of the Walter Oldland pond to the Stewart Gulch road appeared to influence its use by ducks. Individuals that settled on the pond remained only an average of 15 minutes, and spent very little time foraging. Depth of this impoundment, poorly developed shoreline vegetation, and proximity of the road all probably combine to account for the low usage as compared to that of the P-L Ranch pond.

Raptorial Birds

Five raptorial species were found to use the tract during January. The rough-legged hawk, golden eagle, and American kestrel were the falconiform species encountered; and the great horned owl and snowy owl were the strigiform species noted. Table I-11 presents calculated relative abundance of raptorial species on Tract C-b as computed from winter field investigations.

Golden eagles were seen on eight occasions. On January 21 a pair were observed performing aerial courtship displays in the vicinity of nest site number 6 (Table I-3, First Quarterly Report). Although nesting will not begin until early May, displays of this nature are not uncommon during mid-winter (Bent, 1961; Craighead and Craighead, 1956; Brown and Amadon, 1968).

Table I-8. RELATIVE ABUNDANCE OF WATERFOWL SPECIES ENCOUNTERED AT THE WALTER OLDLAND POND AND THE P-L RANCH POND, JANUARY 1975[a]

	WALTER OLDLAND POND			P-L RANCH POND	
Species	Number Recorded	% Relative Abundance[b]	Species	Number Recorded	% Relative Abundance
Mallard	54	68.4	Mallard	78	36.1
Green-winged teal	9	11.4	Gadwall	7	3.2
American wigeon	13	16.5	Green-winged teal	71	32.9
Common goldeneye	3	3.7	Common goldeneye	22	10.2
			Barrow's goldeneye	1	<1.0
			Bufflehead	25	11.6
			Red-breasted merganser	4	1.8
TOTAL	79	100.0		216	100.0

[a]Computed from winter survey conducted January 21-23, 1975

[b]Percentage Relative Abundance was calculated as:

$$\% \text{ Relative Abundance} = \frac{\text{Number of Species A}}{\text{Sum of all Species}} \times 100$$

Table I-9. WATERFOWL UTILIZATION ON THE P-L RANCH POND, COMPUTED FROM THE WINTER SURVEY, JANUARY 1975

	JANUARY 21			JANUARY 22			JANUARY 23	
Species	Number Recorded	Bird-Use Days*	Species	Number Recorded	Bird-use Days	Species	Number Recorded	Bird-use Days
Mallard	33	8.25	Mallard	34	34	Mallard	11	5.5
Gadwall	7	1.75	Green-winged teal	25	12.5	Green-winged teal	12	6
Green-winged teal	34	8.5	Common goldeneye	8	4	Common goldeneye	2	1
American wigeon	8	2	Red-breasted merganser	4	2	Bufflehead	4	2
Common goldeneye	12	3						
Barrow's goldeneye	1	0.25						
Bufflehead	21	5.25						
TOTALS	116	29		71	35.5		64.5	32.25

*Total bird-use days calculated as:

$$\text{Bird-use days} = \frac{\text{Average or mean sum of species recorded/day}}{\text{Total number of observations/day}}$$

Table I-10. WATERFOWL UTILIZATION OF THE WALTER OLDLAND POND, COMPUTED FROM THE WINTER SURVEY, JANUARY 1975

	JANUARY 22			JANUARY 23	
Species	Number Recorded	Bird-Use Days*	Species	Number Recorded	Bird-Use Days*
Mallard	7	2.3	Mallard	47	23.5
Green-winged teal	9	3	American wigeon	13	6.5
Common goldeneye	3	1			
TOTAL	19	6.3		60	30

*Total bird-use days calculated as:

$$\text{Bird-use days} = \frac{\text{Average or mean sum of species recorded/day}}{\text{Total number of observations/day}}$$

Table I-11. RELATIVE ABUNDANCE OF RAPTORIAL SPECIES ON TRACT C-b, COMPUTED FROM WINTER FIELD INVESTIGATIONS, JANUARY 1975

Species	Number Observed	% Relative Abundance*
Rough-legged hawk	38	74.5
Golden eagle	8	15.7
American kestrel	1	2.0
Great horned owl	2	3.9
Snowy owl	2	3.9
TOTAL	51	100.0

*Percentage Relative Abundance was calculated as:

$$\% \text{ Relative Abundance} = \frac{\text{Number of Species A}}{\text{Sum of all Species}} \times 100$$

Rough-legged hawks, which began appearing in the area during late November, were common in the Piceance Basin by mid-January. Most were seen perched on utility poles or searching for rodents over pastures along the creek. The area northwest, north, and northeast of the P-L Ranch, an area 2.5 kilometers in length and 0.75 kilometer wide, supported between 6 and 12 of these hawks. On the morning of January 22, 13 rough-legged hawks were observed for an hour, during which they made 19 successful prey captures.

On January 21 a single male American kestrel was observed north of the P-L Ranch. Although this species is uncommon in this area during winter, it has been suggested (Bent, 1961; Heintzelman and Nagy, 1968) that a small number of American kestrels overwinter in their breeding areas.

During the field period an additional six vacant nest sites (Table I-12) were located, examined, photographed, and plotted on maps (Figure I-4). Five of these nests showed evidences of occupancy during the past breeding season. All are constructed of a loose aggregation of twigs; several had grass intertwined. At nest site number 11, a large number of pellets, castings, and feathers were collected. This nest appears to have been used by common ravens.

Two owl species were recorded. A pair of great horned owls was heard vocalizing the typical five-note call of this species on the evening of January 21. Both birds were perched on an east-facing slope covered by pinyon pine and juniper. This is the same area where a great horned owl was observed during the November field period. The second of the two species encountered was the snowy owl. A single female was seen in Collins Gulch on January 22. She was perched on a large sagebrush 0.75 kilometer north of the Piceance Creek highway. She or another snowy owl was seen east of the Walter Oldland ranch on January 23. These observations should be tentatively considered unusual for this portion of western Colorado. The snowy owl, a species that

Table I-12. VACANT RAPTOR NESTS LOCATED ON TRACT C-b DURING WINTER FIELD INVESTIGATIONS, JANUARY 1975

Nest No.	Species	Nest Location
10	Unknown	NW1/4, Sec. 12 T.3S. R. 97W.
11	Common raven	SW1/4, Sec. 23 T.2S. R. 97W.
12	Unknown	NE1/4, Sec. 26 T.2S. R. 97W.
13	Unknown	NE1/4, Sec. 26 T.2S. R. 97W.
14	Unknown	SW1/4, Sec. 33 T.2S. R. 96W.
15	Unknown	NE1/4, Sec. 22 T.2S. R. 97W.

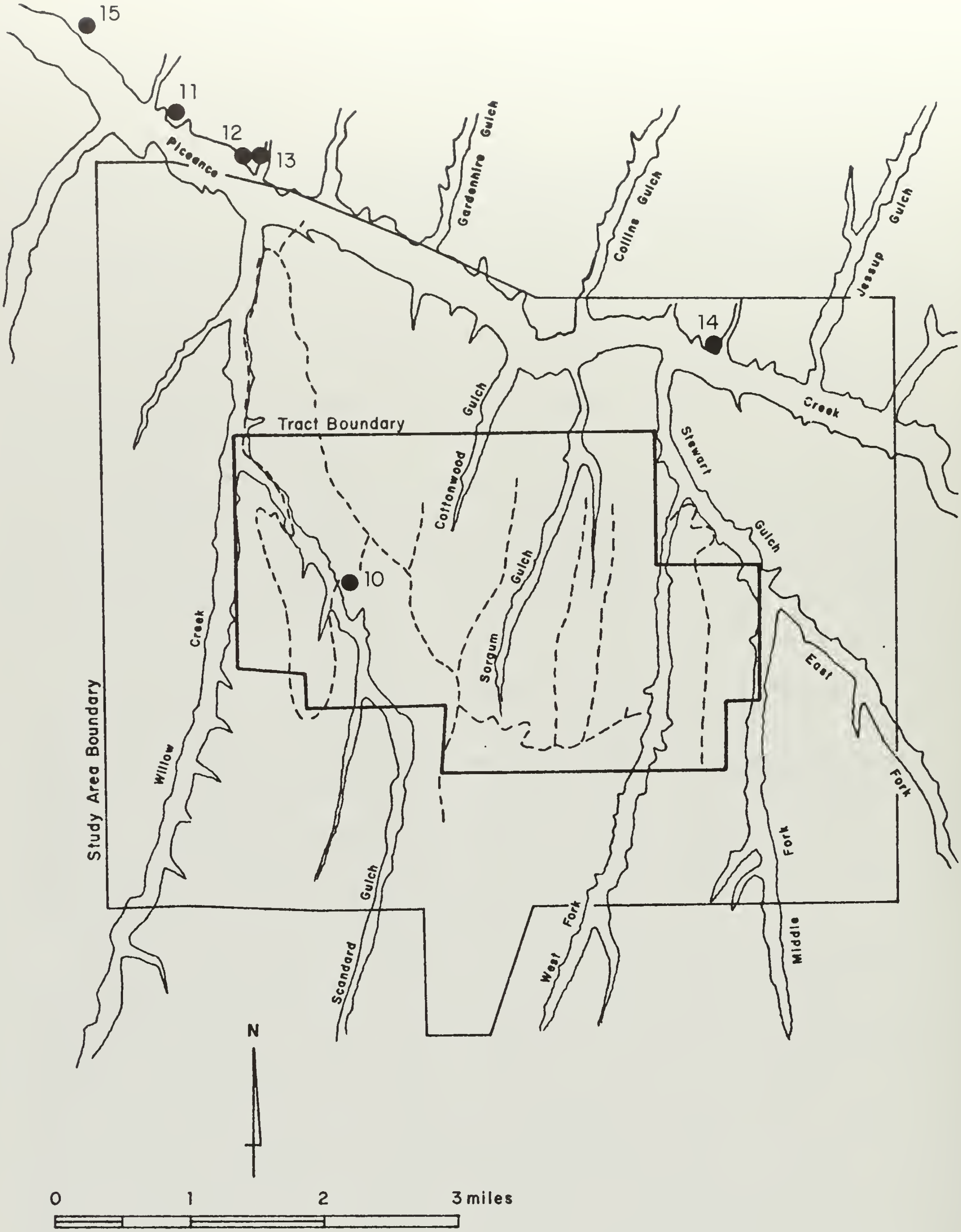

Figure I-4. LOCATIONS OF VACANT RAPTOR NESTS, JANUARY 1975

wanders south from its artic nesting grounds during years of high fledging success or when prey species crash (Murie, 1929; Snyder, 1947, 1949; Watson, 1957), has been recorded on several occasions in this region (Felger, 1910; Aiken and Warren, 1914). Davis (1969) indicated that this owl is a winter visitor but indicates no recent records. Bailey and Niedrach (1965) list this species as an irregular winter visitor.

Species Listing

Tabulation of all species observed during January added 12 species to previous lists from October or November (Table I-13), bringing to 70 the number of bird species found to utilize habitats on Tract C-b during fall and winter months.

Table I-13. SPECIES OF BIRDS OBSERVED ON TRACT C-b DURING JANUARY 1975 WHICH HAD NOT BEEN DOCUMENTED AS PRESENT DURING FALL 1974

Barrow's goldeneye	Downy woodpecker
Black rosy finch	Gray-crowned rosy finch
Brown-capped rosy finch	Plain titmouse
Bufflehead	Prairie falcon
Common goldeneye	Red-breasted merganser
Dark-eyed (Oregon) junco	Snowy owl
Dark-eyed (slate-colored) junco	Wilson snipe

Emlen strip transects accounted for 20 bird species, while qualitative count surveys resulted in 22 species. With the addition of waterfowl surveys, a total of 37 species were documented during January. With only a few exceptions, these species may be considered as typical winter residents and should be expected on the tract each winter.

Species of waterfowl documented on Tract C-b during the January sampling period represent species that should be considered winter residents. Of the eight species recorded, the most abundant were the mallard, green-winged teal, American wigeon, and common goldeneye.

During January several unusual species were encountered. Species considered here have been recorded previously in this portion of western Colorado, but their status is uncertain.

Barrow's Goldeneye. A single male was positively identified at the P-L Ranch pond on January 21, in association with a mixed flock of common goldeneye and bufflehead. The only known documented record of this rare winter migrant (Davis, 1969; Bailey and Neidrach, 1965) was by J. M. Good (1956), who saw a male on the Green River, northeast of Escalante's Crossing.

Red-Breasted Merganser. Four individuals, one male and three females, were observed as they foraged for food and rested on the P-L Ranch pond late in the evening of January 22. Davis (1969) classifies this species as an uncommon winter resident on open rivers. This species has been reported as a frequent visitor to the Green River in northeast Utah and northwest Colorado during migration in early May and late September (Twomey, 1942).

Wilson Snipe. Flushed from Piceance Creek during Emlen censuses and observed foraging in the exposed areas and edge of Stewart Creek, the snipe is given the status of a local breeder on the Western Slope and is restricted to Routt and Gunnison counties (Davis, 1969; Bailey and Neidrach, 1965). Martin, Baldwin, and Reed (1974) indicated that the species arrived in the Yampa Valley during mid-April and remained in the valley until at least September.

Snowy Owl. The lack of literature about this cyclic migrant probably indicates the sparseness of ornithological investigations and species documentations for northwestern Colorado. Since 1910, sightings of only two individuals have been noted in the literature. The presence

of the snowy owl in southern temperate regions is based on cyclic population dynamics in its arctic breeding areas. Davis (1969) and Bailey and Neidrach (1965) suggest that this species is an irregular winter visitor.

Prairie Falcon. The prairie falcon (*Falco mexicanus*), a nationally threatened species, was positively identified near Tract C-b on February 27, 1975, by Dr. Robert Stoecker. It was probably this species that Dr. Stoecker had observed twice before during this winter quarter but which was not identified with certainty. A number of photographs were obtained of the bird sitting on top of a powerline pole near Piceance Creek between Sorghum Gulch and Cottonwood Gulch.

Preliminary Interpretations

The avian population encountered during January generally included species which should be considered typical of these habitats during winter, and most should be found in the area each winter. Most migrant species encountered during the fall inventory had left the tract by January. Some individuals of certain migratory species, such as the red-winged blackbird and western meadowlark, were observed in the Piceance Basin during January but were not documented on the tract or the study areas immediately adjacent to it. Other birds which are regular migratory species, such as the horned lark, American robin, and tree sparrow, migrate in a pattern that is termed "leapfrog" (Thomson, 1936; Bent, 1961; Fraenkel and Gunn, 1961; Lack, 1966; and Clark, 1971). As species begin their southward movements, those inhabiting northern temperate regions move to areas farther south that were previously occupied by different individuals of the same species. This behavioral trait seems prevalent throughout North America in a variety of species. Therefore, American robins and tree sparrows, even though encountered throughout the tract in winter, are most likely individuals that moved into the area after nesting in more northerly localities.

Results of the winter survey exemplified the inconsistency of habitat utilization by bird species in temperate regions during mid-winter. This pattern of distribution results in large areas of a particular habitat remaining devoid of birds at a particular time, while other areas support a large congregation of species (Graber and Graber, 1963). The tendency for many species to flock together during winter influences the degree of interpretation which can be made about relative abundances of different species. The conspicuousness of an individual bird that does not flock, as compared to one that does, decreases its potential of being observed. Therefore, individual conspicuousness and flock conspicuousness may alter the recorded species and population numbers (Brewer, 1972). Moreover, density estimates of species contributing high percentages may be overestimated, while species contributing low percentages may be underestimated.

SOIL MICROARTHROPODS

Soil litter samples were collected in December 1974. They, along with the October samples, have been sorted and identified. A list of the species identified and histograms comparing the changes in abundance of the mite population over the two collection periods have been prepared. An analysis and report of this final work is nearing completion and will be included in the next quarterly report.

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Aquatic Studies

II

AQUATIC STUDIES

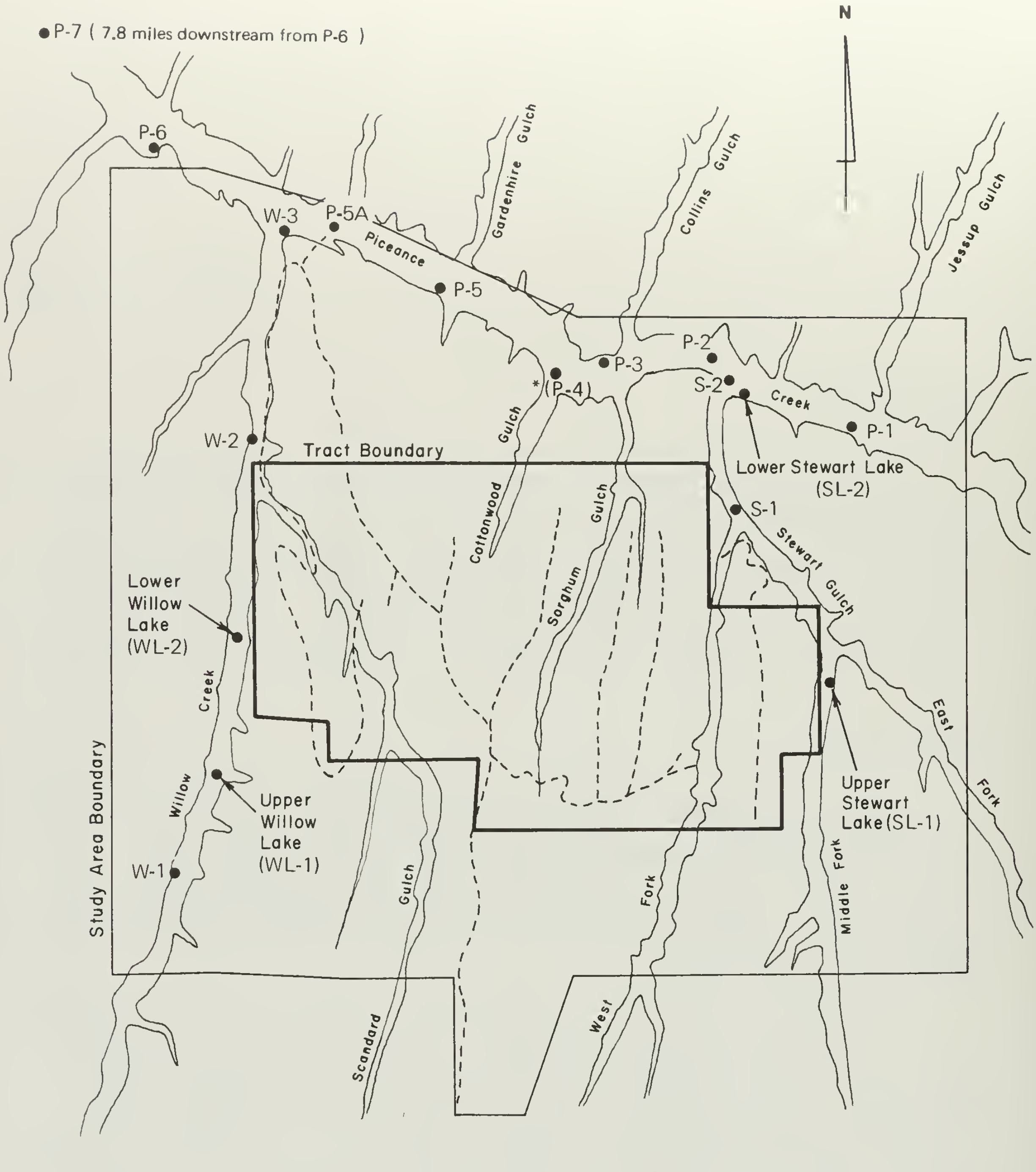
INTRODUCTION

This report represents the compilation of preliminary findings in the aquatic environment during the late summer/winter period. It does not attempt to draw any significant conclusions regarding the total aquatic system, but does make preliminary interpretations. Additional data to be collected will allow for more definitive conclusions of the system as a whole.

SCOPE OF STUDY

Monthly collections of aquatic organisms from the various sampling stations were continued from November 1974 through January 1975. In January, however, bad weather on Tract C-b hampered sampling at some stations. The usefulness of data collected in January may be somewhat diminished by this fact.

The locations and descriptions of the sampling stations are the same as those for the first quarter, with the following exception. The station originally designated as P-4 was relocated due to similarity in data collected at stations P-3 and P-5; P-5A was added to provide a station on a stretch of stream below a waterfall, a habitat of narrow distribution not represented in the other Piceance Creek stations. The locations of these stations are shown in Figure II-1. In addition, there are two stations on the White River; their locations were described in the First Quarterly Report.



*P-4 has been relocated to P-5A

NOTE:

Piceance Creek sites (P-1 thru P-7)
Willow Creek sites (W-1 thru W-3)
Stewart Creek sites (S-1, S-2)
= Roads

Figure II-1. AQUATIC STUDY AREAS

METHODOLOGY

Fish

A variable-voltage, DC-battery-operated backpack shocker is used to collect fish from all stream stations (Figure II-1) bimonthly. Seines with 0.5-inch mesh are used to collect fish from the ponds. These seines are 6 by 100 feet and 6 by 50 feet in size.

In order to obtain quantitative data on fish populations in the streams, a 100-meter stretch of stream is fished with the backpack shocker. After removal from the stream, fish are kept in a live-box until they are weighed, measured, and marked; then they are returned to the stream.

To detect any migration of game fish, captured fish are marked and released alive.

Benthos

Benthic macroinvertebrates (bottom-dwelling organisms) are collected at all stations with a Surber square-foot stream-bottom sampler (Needham and Needham, 1962). The apparatus consists of a lightweight brass frame which encloses a square foot of bottom, and to which a net is attached.

The sampler is placed on the bottom with the opening of the net facing upstream. The larger stones are washed and discarded, then the remaining substrate is gently churned up to suspend burrowing organisms. The current carries the organisms into the net. Samples are taken in triplicate at each station for statistical comparison. Samples are preserved in 70 percent methanol and returned to the laboratory. Since most quantitative studies utilize the Surber sampler, the results obtained in this survey can be compared with results presented in published work.

In the laboratory the benthic samples are washed, sorted into major groups (insects, leeches, snails, etc.), identified, and tallied. A biomass value for each major group, by station, is determined to the nearest milligram with a Mettler Balance.

Periphyton

Periphyton (attached plants and microinvertebrates) are collected from each station by removing six glass slides (3 x 5 inches) from a holder which has been immersed in the stream for about a month. Three of the six slides are preserved in vials of formalin for qualitative analysis of the algae. The other three slides are air-dried and stored for quantitative analysis.

Periphyton are examined qualitatively and quantitatively in the laboratory. For qualitative analysis (identification) the glass slides are scraped with a razor blade, mixed with water, and a 1-milliliter aliquot is placed in a Sedgewick-Rafter cell. The periphytic algae are then identified to genus at 125x magnification.

Quantitative analysis is accomplished by drying overnight at 110°C and scraping the periphyton from each slide separately into a prepared weighing dish. The material is weighed to the nearest ten-thousandth of a gram (0.0001) and the values are recorded. The weights are converted to grams per square meter by the formula:

$$\frac{\text{mean weight of samples (gm)}}{\text{area of slide (cm}^2\text{)}} \times 10{,}000$$

Water Quality

Water samples are collected monthly at each station. The samples are taken on the third Wednesday of each month so as to coincide with water quality analysis performed by the U.S. Geological Survey (USGS) for the same area. Measurements of dissolved oxygen and temperature (using a Yellow Springs dissolved-oxygen meter, Model 51A), pH (using a Photovolt Meter, Model 125), and specific conductivity (using a DREL-2 Hach Kit), are made in the field at the time of collection. Water samples for further analysis are placed in 1-quart plastic containers and put on ice until further analysis in the laboratory. Analyses in the laboratory conform to those specified in APHA Standard Methods (1973) and EPA Publication 16020-07/71.

RESULTS AND DISCUSSION

Fish

Fish were collected in January as part of the continuing program in aquatic baseline studies. During January, however, sampling was greatly curtailed because of ice, snow, and cold weather. Only four stations could be successfully sampled during the field effort: P-2, S-2, SL-2, and W-3. These stations are under the influence of spring-fed water and remain free of ice while other stations are frozen. The White River was completely ice-choked and snow-covered at the time of sampling.

The species of fish collected were the same as those collected in previous sample periods (Table II-1). Once again mountain suckers (*Catostomus platyrhynchus*) were the most abundant fish captured, with an almost equal number of brook trout (*Salvelinus fontinalis*) (Table II-2). Most of the suckers captured came from Piceance Creek. The brook trout were concentrated in Stewart Creek (S-2) and the channel that drains Lower Stewart Lake (SL-2). Station S-2 had not yielded fish during previous sampling periods. The channel is usually choked with watercress and overhanging shrubs, but in winter it is open and easily accessible for sampling. The decreased cover allowed fish to be captured more easily than in the past.

The number of fish captured at P-2 in January was greater than the combined total of the two previous sampling periods. The number of fish captured at SL-2 was only slightly smaller than the combined total for the previous sampling periods. It appears that the increase in numbers of fish at these locations may be due to the fact that the fish were apparently attracted to these ice-free sections when much of Piceance Creek was ice-clogged.

Length-Weight Tables. Data on the lengths and weights of fish can be helpful in examining the relative structure of a fish population. If clumping occurs in the distribution of fish over a range of lengths, the

Table II-1. SPECIES OF FISH CAPTURED DURING JANUARY 1975

Scientific Name	Common Name
Salmo gairdneri	Rainbow trout
Salvelinus fontinalis	Brook trout
Rhinichthys osculus	Speckled dace
Catostomus platyrhynchus	Mountain sucker

Table II-2. NUMERICAL ABUNDANCE OF SPECIES OF FISH CAPTURED DURING JANUARY 1975

	SPECIES				
STATION	Rainbow Trout	Brook Trout	Speckled Dace	Mountain Sucker	Total Number
P-2		1		71	72
W-3				6	6
S-2		36	15	11	62
SL-2	1	42	2		45
TOTAL	1	79	17	88	185

clumps may represent various age groups within a population. This can be correlated with aging of the fish from their scales. Age structure can give some insight into the condition of the fish population.

The mean lengths and weights of the fish captured in September, November, and January are presented in Tables II-3, -4, and 5. The mean length of mountain suckers (154.5 mm) in January is similar to the mean lengths of suckers captured during September (158.1 mm) and November (169.3 mm). At station SL-2, the mean length of brook trout in January (146.2 mm) was longer than the mean lengths in September (96.4 mm) and November (130.3 mm). Part of the length increase can be attributed to growth of the fish and also to inclusion of several larger fish in the sample. The mean length of brook trout at station S-2 was 121.0 mm, slightly less than the value for SL-2. Since there were no previous captures of fish at this station, no comparisons can be made.

Length frequencies for the mountain suckers in September, November, and January are given in Tables II-6, -7, and -8. The frequency distributions for all stations over the three sampling periods are shown in Table II-9. Figures II-2, -3, and -4 depict possible age groupings by size. From the tables it can easily be noted that most suckers fell in the length range of 120 to 160 mm. These fish probably represent the dominant year class in the population of mountain suckers. Other year classes may be present in the ranges >190 mm and <120 mm.

The length-frequency relationship for brook trout from all stations to date is summarized in Table II-9A. The largest number of individuals are in the range of 110 to 140 mm (Figure II-5). This is probably a single year class grouping. The distribution of fish greater than 150 mm in length indicates that a few fish remain from older year classes.

Preliminary Evaluation. In order to give a quantitative value to a comparison of the various stations on the four streams being sampled, a similarity index was computed (Soerensen's Index of Similarity).

Table II-3. MEAN LENGTHS AND WEIGHTS OF FISH CAPTURED DURING SEPTEMBER 1974

Station	Species*	Number Collected	Mean Length (mm)	Range (mm)	Mean Weight (mg)	Range (mm)
P-1	C. platyrhynchus	104	136.5	(85-190)	23.6	(6-72)
	R. osculus	30	85.0	(69-104)	4.4	(2-8)
P-2	C. platyrhynchus	24	158.1	(118-208)	48.4	(20-94)
P-3	C. platyrhynchus	2	194.5	(172-217)	90.0	(62-118)
P-4	C. platyrhynchus	1	136.0	-	30.0	-
P-5	C. platyrhynchus	3	141.0	(140-143)	33.3	(28-36)
P-6	C. platyrhynchus	18	100.5	(71-175)	12.7	(4-28)
	R. osculus	6	73.8	(52-92)	4.8	(1-10)
P-7	C. platyrhynchus	2	165.0	(155-175)	48.0	(36-60)
	R. osculus	8	73.5	(57-91)	7.0	4-12)
W-3	C. platyrhynchus	1	114.0	-	14.0	-
	R. osculus	1	81.0	-	6.0	-
	S. fontinalis	1	16.0	-	103.0	-
SL-2	S. fontinalis	36	96.4	(70-255)	19.1	(1-170)

*Species Legend:
Catastomus platyrhynchus (mountain sucker)
Rhinichthys osculus (speckled dace)
Salvelinus fontinalis (brook trout)

Table II-4. MEAN LENGTHS AND WEIGHTS OF FISH CAPTURED DURING NOVEMBER 1974

Station	Species*	Number Collected	Mean Length (mm)	Range (mm)	Mean Weight (mg)	Range (mg)
P-1	C. platyrhynchus	44	127.9	(91-170)	20.05	(4-44)
	R. osculus	4	83.7	(80-88)	3.3	(2-4)
	S. fontinalis	1	142.0	-	22.0	-
	S. trutta	1	322.0	-	366.0	-
P-2	C. platyrhynchus	14	169.3	(131-205)	60.0	(22-96)
P-3	C. platyrhynchus	48	144.1	(81-200)	36.3	(8-92)
	R. osculus	2	67.5	(64-71)	6.0	(6-6)
P-4	R. osculus	2	63.0	(61-65)	3.0	(2-4)
P-5	C. platyrhynchus	7	124.7	(81-150)	14.3	(2-36)
P-6	None collected	-	-	-	-	-
P-7	None collected	-	-	-	-	-
W-3	C. platyrhynchus	1	180.0	-	56.0	-
	S. fontinalis	2	237.0	(130-344)	212.0	(24-400)
WR-1	C. latipinnis	1	450.0	-	884.0	-
	R. osculus	1	78.0	-	6.0	-
	C. bairdi	1	115.	-	14.0	-
SL-2	S. fontinalis	15	130.3	(73-246)	24.73	(2-146)

*Species Legend:
- Catostomus platyrhynchus (mountain sucker)
- Catostomus latipinnis (flannel mouth sucker)
- Rhinichthys osculus (speckled dace)
- Cottus bairdi (mottled sculpin)
- Salmo trutta (brown trout)
- Salvelinus fontinalis (brook trout)

Table II-5. MEAN LENGTHS AND WEIGHTS OF FISH CAPTURED DURING JANUARY 1975

Station	Species *	No. Collected	Mean Length (mm)	Range	Mean Weight (gms.)	Range
P-2	C. platyrhynchus	71	154.5	(100-212)	39.0	(8-102)
	S. fontinalis	1	135.0	---	18	---
W-3	C. platyrhynchus	6	111.3	(88-140)	12.7	(4-22)
S-2	C. platyrhynchus	11	130.7	(102-157)	20.4	(8-34)
	R. osculus	15	90.8	(77-124)	6.5	(4-18)
	S. fontinalis	36	127.4	(101-150)	14.6	(6-28)
SL-2	R. osculus	2	85.0	(82-88)	4	---
	S. gairdneri	1	202.0	---	86.0	---
	S. fontinalis	42	149.4	(92-293)	36.3	(6-202)

* Species Legend:

Catostomus platyrhynchus (mountain sucker

Rhinichthys osculus (speckled dace)

Salmo gairdneri (rainbow trout)

Salvelinus fontinalis (brook trout)

Table II-6. LENGTH-FREQUENCY DISTRIBUTION OF MOUNTAIN SUCKERS CAPTURED IN PICEANCE CREEK, SEPTEMBER 1974

Class Interval (mm)	Station P-1	P-2	P-3	P-4	P-5	P-6	P-7	Total
70-79						4		4
80-	3					4		7
90-	6					3		9
100-	2							2
110-	1	1				2		4
120-	12					1		13
130-	17	5		1		3		26
140-	12	6			3	1		22
150-	4	2					1	7
160-	3	1						4
170-	1	4	1				1	7
180-	3	2						5
190-	2	1						3
200-		2						2
210-219			1					1

Table II-7. LENGTH-FREQUENCY DISTRIBUTION OF MOUNTAIN SUCKERS CAPTURED IN PICEANCE CREEK, NOVEMBER 1974

Class Interval (mm)	Station P-1	P-2	P-3	P-4	P-5	P-6	P-7	Total
80-89	1		2		1			4
90-	4							4
100-								
110-	4				1			5
120-	14		3		1			18
130-	9	1	10		3			23
140-	6		15					21
150-	2	4	9		1			16
160-	2	2	7					11
170-	2	2						4
180-		3	2					5
190-								
200-209		2	1					3

Table II-8. LENGTH-FREQUENCY DISTRIBUTION OF MOUNTAIN SUCKERS CAPTURED IN PICEANCE CREEK, JANUARY 1975

Class Interval (mm)	Station P-2
80-89	2
90-	1
100-	3
110-	1
120-	15
130-	12
140-	20
150-	5
160-	9
170-	6
180-	6
190-	1
200-	5
210-220	2

Table II-9. LENGTH-FREQUENCY DISTRIBUTION OF MOUNTAIN SUCKERS OVER THREE SAMPLING PERIODS

Class Interval (mm)	SAMPLE DATE 1974 September	SAMPLE DATE 1974 November	SAMPLE DATE 1975 January
70-79	4		
80-	7	4	2
90-	9	4	1
100-	2		3
110-	4	5	1
120-	13	18	15
130-	26	23	12
140-	22	21	20
150-	7	16	5
160-	4	11	9
170-	7	4	6
180-	5	5	6
190-	3		1
200-	2	3	5
210-	1		2
220-229			

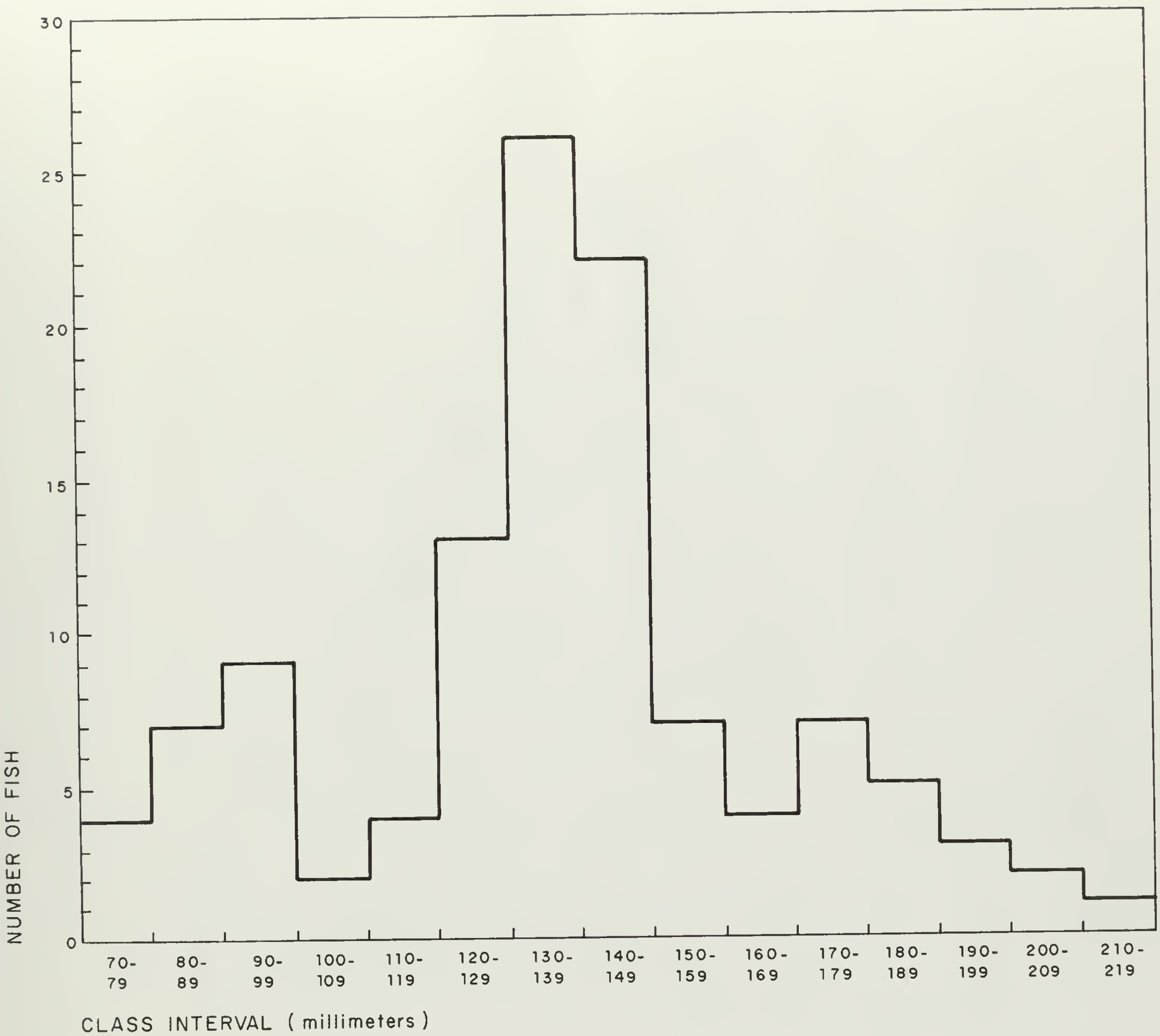


Figure II-2. LENGTH-FREQUENCY DISTRIBUTION OF MOUNTAIN SUCKERS CAPTURED IN PICEANCE CREEK, SEPTEMBER 1974

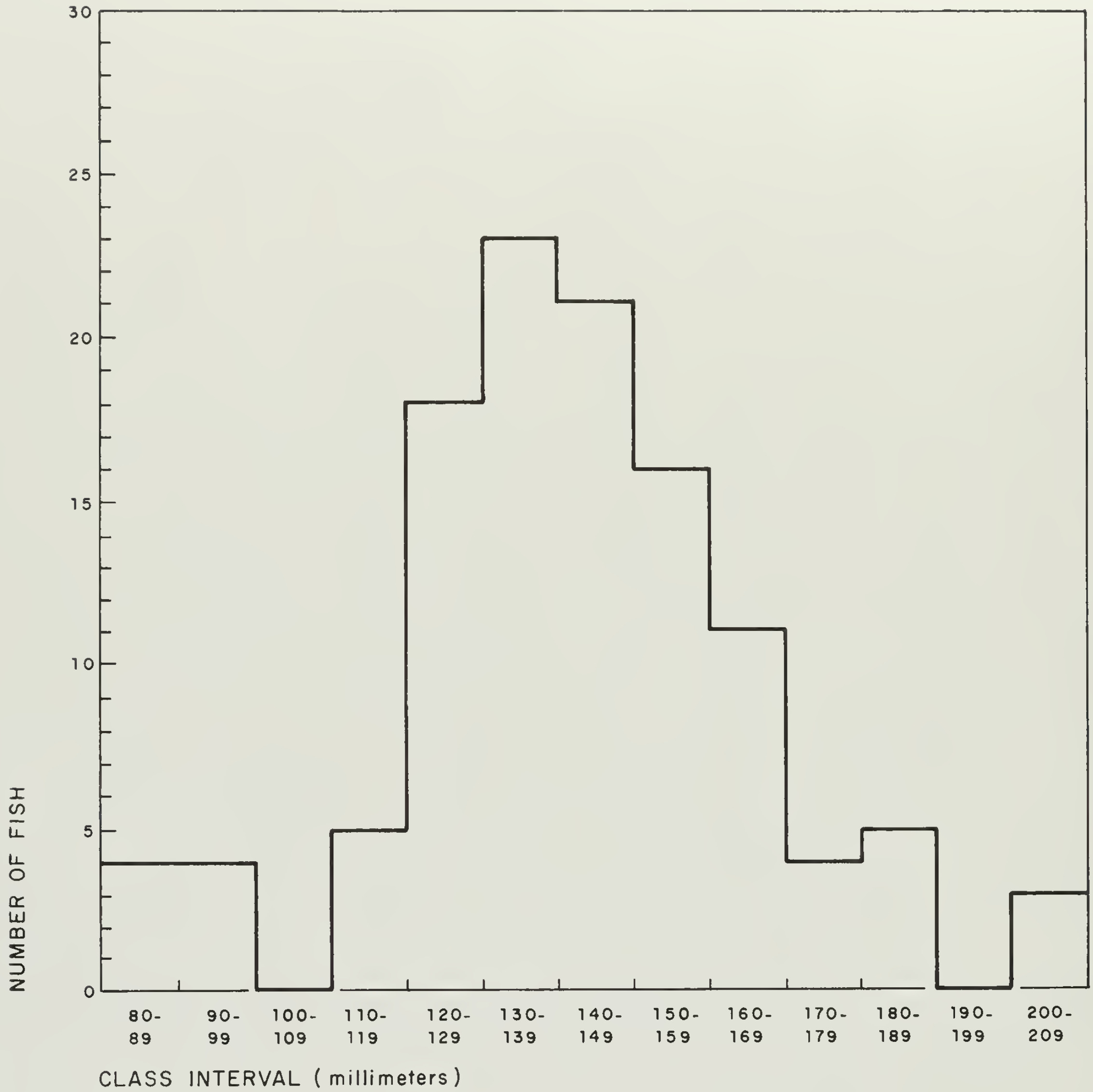


Figure II-3. LENGTH-FREQUENCY DISTRIBUTION OF MOUNTAIN SUCKERS CAPTURED IN PICEANCE CREEK, NOVEMBER 1974

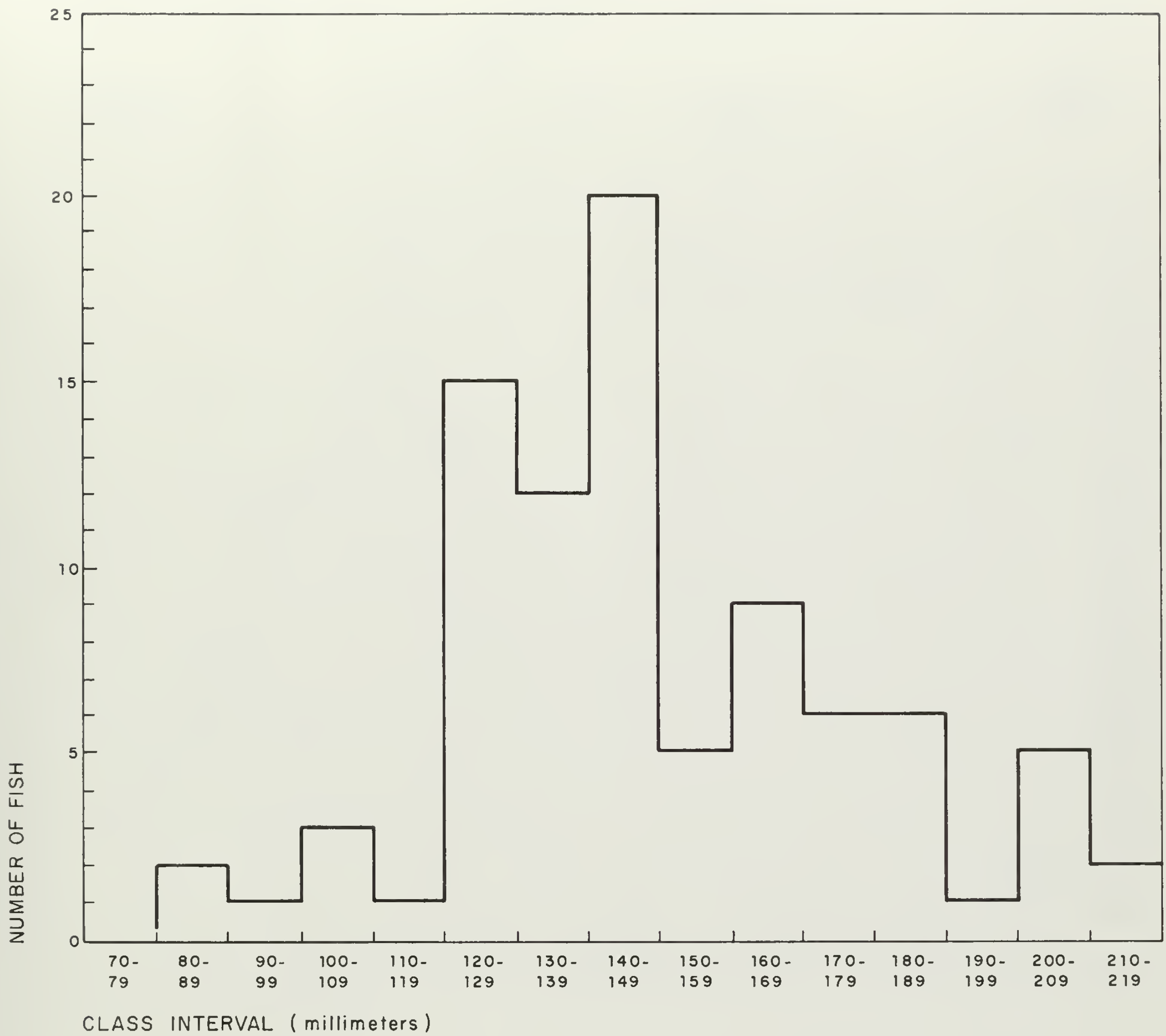


Figure II-4. LENGTH-FREQUENCY DISTRIBUTION OF MOUNTAIN SUCKERS CAPTURED IN PICEANCE CREEK, JANUARY 1975

Table II-9A. LENGTH-FREQUENCY DISTRIBUTION OF BROOK TROUT OVER THREE SAMPLING PERIODS

Class Interval (mm)	SAMPLE DATE 1974		1975
	September	November	January
70-79	6	1	
80-	3		
90-	6		5
100-	7		8
110-	6	4	12
120-	3	4	13
130-	3	4	18
140-	1	3	13
150-			3
160-			1
170-			1
180-			
190-			
200-			
210-			1
220-			
230-			1
240-		1	1
250-259	1		2
> 260	1		

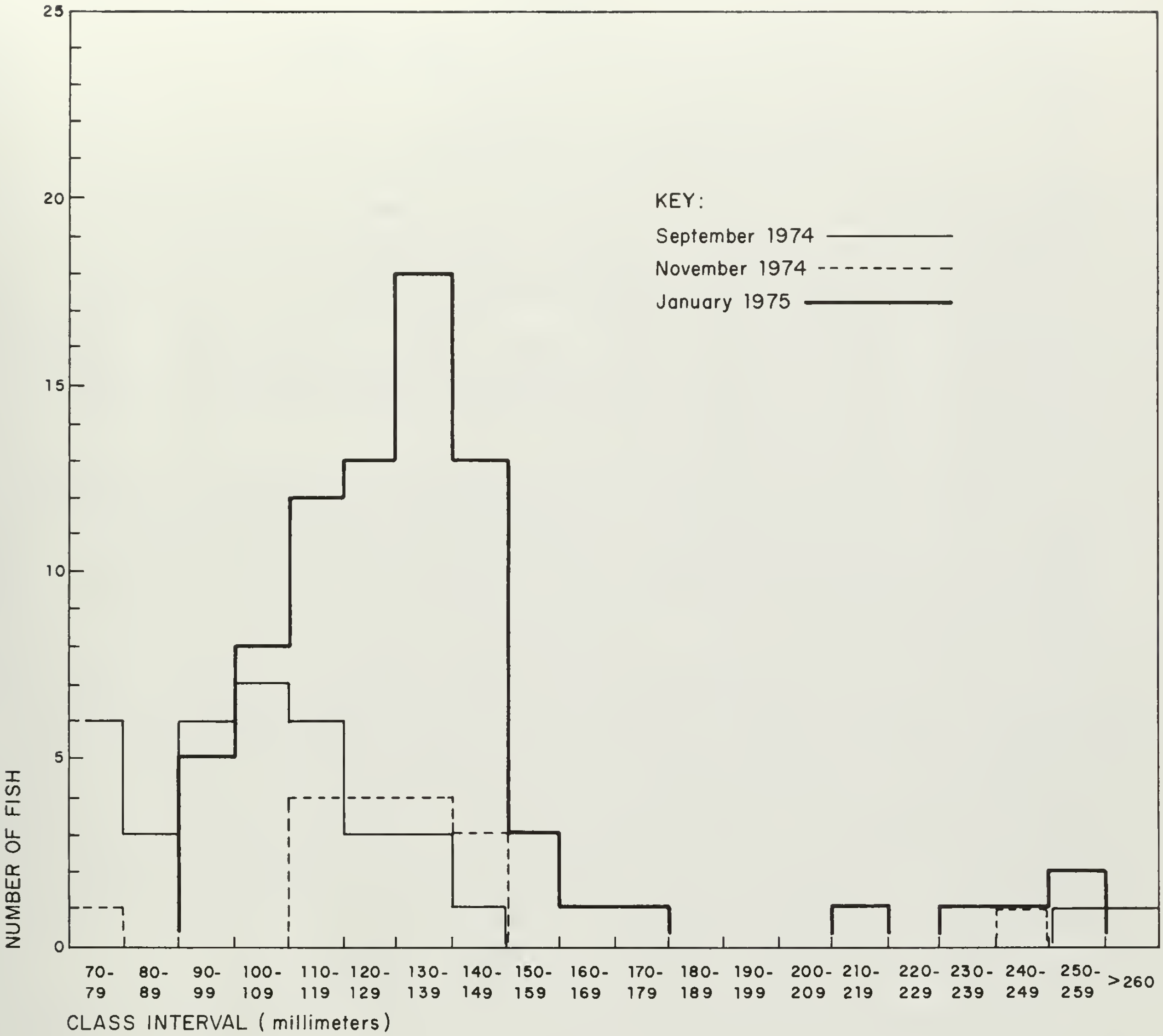


Figure II-5. LENGTH-FREQUENCY DISTRIBUTION OF BROOK TROUT CAPTURED IN THE PICEANCE BASIN OVER THREE SAMPLING PERIODS: SEPTEMBER AND NOVEMBER 1974 AND JANUARY 1975

Soerensen's Index of Similarity (K) is given by:

$$K = \frac{2j}{A + B}$$

where j = number of species common to both samples

A = number of species in sample A

B = number of species in sample B.

Values range from 1 — if all the species are common to both samples, to 0 — if none of the species is common to both samples. Because there is no statistical significance level attached to the index, an arbitrary similarity value (0.65) is selected above which the two samples are considered similar, and below which they are considered dissimilar (Krebs, 1972; Cox, 1972; Greig-Smith, 1964).

The similarity of species composition between stations is shown in Table II-10. The distribution of species captured at the various stations is presented in Table II-11 to supplement the Soerenson's Index of Similarity.

When Table II-10 is examined it becomes apparent that most stations on Piceance Creek are similar to each other, with the exception of stations P-2 and P-5A. P-2 was similar in species composition to station P-1 but was not similar to the downstream stations. The main cause of this is the fact that brook trout were captured only at P-1 and P-2, and none was captured farther downstream. In addition, no dace have been captured at P-2 but they have been captured at other stations.

Only suckers have been captured at station P-5A, so it does not appear to be similar to other stations along Piceance Creek. It is also evident that the species composition from stations W-3 and S-2 are similar to those along Piceance Creek. Station SL-2 is not similar to the stations along Piceance Creek but is similar to stations S-2 and W-3. This is not surprising, since S-2 is immediately adjacent to stations SL-2, and station W-3 is of similar substrate and water quality.

Table II-10. SOERENSON'S INDEX OF SIMILARITY (K) OF SPECIES OF FISH BETWEEN STATIONS* (Number of species at a station summed over all samples at the station.)

STATIONS	P-1	P-2	P-3	P-5	P-5A	P-6	P-7	W-3	S-2	L.S.L.	WR-1	WR-2
P-1	X	0.67	0.67	0.67	0.33	0.67	0.67	0.86	0.86	0.57	0.0	0.0
P-2		X	0.50	0.50	0.50	0.50	0.50	0.80	0.80	0.40	0.0	0.0
P-3			X	1.0	0.50	1.0	1.0	0.80	0.80	0.40	0.0	0.0
P-5				X	0.50	1.0	1.0	0.80	0.80	0.40	0.0	0.0
P-5A					X	0.50	0.50	0.40	0.40	0.40	0.0	0.0
P-6						X	1.0	0.80	0.80	0.40	0.0	0.0
P-7							X	0.80	0.80	0.40	0.0	0.0
W-3								X	1.0	0.67	0.0	0.0
S-2									X	0.67	0.0	0.0
SL-2										X	0.0	0.0
WR-1											X	0.75
WR-2												X

*K indicates the relative degree of similarity between two samples with respect to a particular parameter. A value of 1.0 indicates the samples are identical while a zero value indicates no similarity. 0.650 is considered the break point below which the pairs are not considered similar and above which they are considered similar.

Table II-11. DISTRIBUTION OF SPECIES OF FISH CAPTURED DURING SEPTEMBER AND NOVEMBER 1974 AND JANUARY 1975

	SPECIES							
STATION	Rainbow trout	Brown trout	Brook trout	Flannel-mouth sucker	Mountain sucker	Speckled dace	Mottled sculpin	Total
P-1		X	X		X	X		4
P-2			X		X			2
P-3					X	X		2
P-5					X	X		2
P-5A					X			1
P-6					X	X		2
P-7					X	X		2
W-3			X		X	X		3
S-2			X		X	X		3
SL-2	X		X		X			3
WR-1				X			X	2
WR-2							X	1

It should be noted that the two stations on the White River, WR-1 and WR-2, are not similar to the other stations. This would be expected since this is a river rather than a small stream environment.

Benthos

Benthic macroinvertebrates were collected from all aquatic stations during November, December, and from most stations in January. The numerical abundance and species composition of the benthic invertebrates are presented in Tables II-13 through II-47, while a taxonomic listing is provided in Table II-12. The benthic invertebrates are represented by three phyla: annelids, arthropods, and molluscs. Of these, the arthropods are the most numerous and are represented by 10 orders and 37 identified genera.

During this quarter much of the reduced aquatic data have been treated statistically to reach an objective decision regarding stated hypotheses. The test used (Kruskal-Wallis one-way analysis of variance; Komolgorov-Smirnov one-sample test; and Mann-Whitney U test) are nonparametric techniques which do not require the stringent assumptions of parametric tests such as normal distributions and homogeneity of variances (Siegal, 1956; Zar, 1974). The stated null hypotheses (H_o) are that samples between and within stations, and samples between months, have come from the same population ($H_o = H_a$). The alternative hypotheses (H_a) are that samples between and within stations, and samples between months, have come from different populations ($H_o \neq H_a$).

Statistical analyses generally allow a more critical and unbiased evaluation of the data than do qualitative comparisons and include an estimate of the degree of uncertainty involved in the conclusion reached. For example, the statement that "benthic biomass changes significantly within a station over time (p = 0.05) as determined by a Kruskal-Wallis

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Table II-12. COMMON AND TAXONOMIC NAMES OF BENTHIC MACROINVERTEBRATES COLLECTED FROM PICEANCE CREEK, WILLOW CREEK, STEWART CREEK, AND THE WHITE RIVER DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975

COMMON NAME		TAXA
	Phylum	ANNELIDA
Aquatic earthworms	Class	Oligochaeta
Leeches		Hirudinea
	Phylum	ARTHROPODA
	Class	Insecta
Mayflies	Order	Ephemeroptera
	Family	Baetidae
	Genus	Ameletus
		Baetis
		Caenis
		Ephemerella
		Pseudocloeon
		Heptageniidae
		Heptagenia
		Rhithrogena
		Stenonema
Damselflies & Dragonflies		Odonata
		Gomphidae
		Gomphus
Stoneflies		Plecoptera
		Nemouridae
		Capniinae
		Taeniopteryginae
		Perlodidae
		Isogenus
		Isoperla
True bugs		Hemiptera
		Notonectidae
		Notonecta
Aphids *		Homoptera
		Aphididae

*Terrestrial insect collected in benthic sample.

Table II-12 (Continued)

COMMON NAME	TAXA
Beetles	Coleoptera
	Dryopidae
	Helichus
	Throscinus
	Dytiscidae
	Agabinus
	Hydroporus
	Elmidae
	Heterlimnius
	Stenelmis
	Hydrophilidae
	Hydrophilinae
	Paracymus
Caddisflies	Trichoptera
	Brachycentridae
	Brachycentrus
	Micrasema
	Hydropsychidae
	Hydropsyche
	Macronemum
	Hydroptilidae
	Hydroptila
	Psychomyiidae
	Psychomyia
True flies	Diptera
	Anthomyiidae
	Limnophora
	Ceratopogonidae
	Chironomidae
	Chironomus
	Deuterophlesiidae
	Deuterophlegia
	Dixidae
	Dixa
	Rhagionidae
	Simuliidae
	Simulium
	Stratiomyidae
	Odontomyia

Table II-12 (Concluded)

COMMON NAME	TAXA
	Tabanidae
	Tipulidae
	Crustacea
Scuds	Amphipoda
	Gammaridae
	Gammarus
	Talitridae
	Hyalella
Water mites	Hydracarina
	MOLLUSCA
Snails	Gastropoda
	Pulmonata
	Physidae
	Lymnaeidae

Table II-13. DIPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM PICEANCE CREEK DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975*

Taxa	Station																								Total Number of Individuals
	P-1			P-2			P-3			P-4*			P-5			P-5A			P-6			P-7			
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
NOVEMBER																									
Chironomus	130	61	59	6	5	1	27	13	3	9	3	3	15	7	11	47	15	6	6			4	5	6	444
Simulium	6	13	21	3	3	1		1	2	4			5	138	5	3							1	1	207
Limnophora	1	1	1			1	3		1			1													9
Odontomyia							1	2																	3
Dixa																									0
Deuterophlegia																									0
Rhagionidae																									0
Tipulidae	2	1	3		2		2	2	2				1	1		1		2	1						20
Tabanidae								1																	1
Ceratopogonidae							1			2															3
																								TOTAL	687
DECEMBER																									
Chironomus	16	2	25	122	28	47	11	27	11				1	11	4	36	22	20			3	1	1		388
Simulium	1			2	1		1	7	4					5	2			1				2	1		27
Limnophora				4	1				1						1			1							8
Odontomyia																									0
Dixa																									0
Deuterophlegia																									0
Rhagionidae																									0
Tipulidae				1	1	2		1	1																6
Tabanidae									1												1				2
Ceratopogonidae								1																	1
																								TOTAL	432
JANUARY																									
Chironomus	4	42	16	16	19	17	46	94	33				23	16	3	1	1		1	1			3	10	347
Simulium		1		3			1	3	4				6	5								1	3	22	49
Limnophora	4	1	1	1	1	2		1	1				1		1				1						15
Odontomyia																									0
Dixa																									0
Deuterophlegia																									0
Rhagionidae																									0
Tipulidae					1														1						2
Tabanidae																									0
Ceratopogonidae																									0
																								TOTAL	413

*Station P-4 was relocated to P-5A in December 1974.

Table II-14. PLECOPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM PICEANCE CREEK DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975

Taxa	Station																								Total Number of Individuals
	P-1			P-2			P-3			P-4*			P-5			P-5A			P-6			P-7			
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
NOVEMBER																									
Isoperla	1		2				2	3			1		1	1											11
Isogenus																									0
Capniinae																									0
Taeniopteryginae																									0
																								TOTAL	11
DECEMBER																									
Isoperla				2					2										1						5
Isogenus																									0
Capniinae																									0
Taeniopteryginae																									0
																								TOTAL	5
JANUARY																									
Isoperla						1	2	13	11				11	6	1										45
Isogenus																									0
Capniinae																									0
Taeniopteryginae																									0
																								TOTAL	45

*Station P-4 was relocated to P-5A in December 1974.

Table II-15. TRICHOPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM PICEANCE CREEK DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975*

Taxa	Station																								Total Number of Individuals
	P-1			P-2			P-3			P-4**			P-5			P-5A			P-6			P-7			
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
NOVEMBER																									
Hydropsyche									1																1
Macronemum										1															1
Micrasema																									0
Brachycentrus																									0
Hydroptila																									0
Psychomyia																									0
																								TOTAL	2
JANUARY																									
Hydropsyche						3																			3
Macronemum																									0
Micrasema																									0
Brachycentrus																									0
Hydroptila																									0
Psychomyia																									0
																								TOTAL	3

*The Order Trichoptera was not present in December 1974 samples.

**Station P-4 was relocated to P-5A in December 1974.

Table II-16. COLEOPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM PICEANCE CREEK DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975

Taxa	Station																								Total Number of Individuals
	P-1			P-2			P-3			*P-4			P-5			P-5A			P-6			P-7			
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
NOVEMBER																									
Agabinus																									0
Hydrophilinae																									0
Helichus																									0
Stenelmis	1												1												2
Heterlimnius	1	1	2				3	3					2	3	1	1	2								19
Hydroporus																									0
Throscinus																									0
Paracymus																									0
																								TOTAL	21
DECEMBER																									
Agabinus								1																	1
Hydrophilinae																									0
Helichus																									0
Stenelmis																									0
Heterlimnius				1																					1
Hydroporus																									0
Throscinus																									0
Paracymus																									0
																								TOTAL	2
JANUARY																									
Agabinus																									0
Hydrophilinae																									0
Helichus																									0
Stenelmis																									0
Heterlimnius									1	4															5
Hydroporus																									0
Throscinus																									0
Paracymus																									0
																								TOTAL	5

*Station P-4 was relocated to P-5A in December 1974.

Table II-17. EPHEMEROPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM PICEANCE CREEK DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975

Taxa	Station																								Total Number of Individuals
	P-1			P-2			P-3			P-4*			P-5			P-5A			P-6			P-7			
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
NOVEMBER																									
Baetis	37	2	20	3	5	4	7	12	12	5	1	2	9	51	7	8	5		1						191
Ephemerella	7	1	11				4	6					2		2	4	6								43
Pseudocloeon	13		5	5	2	1		6	2	5	1	7	26	25	16	16	15	7							152
Caenis																	1								1
Ameletus																									0
Heptagenia																									0
Rhithrogena																									0
Stenonema																									0
																								TOTAL	387
DECEMBER																									
Baetis				11	1			4	15				3	6	8	1		2		1	1				53
Ephemerella				1			1	1								1					1				5
Pseudocloeon									1					1		6					1				9
Caenis																									0
Ameletus																						1			1
Heptagenia																									0
Rhithrogena																									0
Stenonema																									0
																								TOTAL	68
JANUARY																									
Baetis	12	24	58	27	15	15	4	61	107				81	20		5	3	4	13	18	17			5	489
Ephemerella				3				2	5					4											14
Pseudocloeon																									0
Caenis																									0
Ameletus																									0
Heptagenia																									0
Rhithrogena																									0
Stenonema																									0
																								TOTAL	503

*Station P-4 was relocated to P-5A in December 1974.

Table II-18. AMPHIPODA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM PICEANCE CREEK DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975*

Taxa	Station																								Total Number of Individuals
	P-1			P-2			P-3			P-4**			P-5			P-5A			P-6			P-7			
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
NOVEMBER																									
Gammarus																									0
Hyalella							1	1																	2
																								TOTAL	2
JANUARY																									
Gammarus				2	1								2												5
Hyalella														1											1
																								TOTAL	6

*The Order Amphipoda was not found on Piceance Creek during December 1974.

**Station P-4 was relocated to P-5A in December 1974.

Table II-19. MOLLUSCA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM PICEANCE CREEK DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975*

Taxa	Station																								Total Number of Individuals
	P-1			P-2			P-3			P-4**			P-5			P-5A			P-6			P-7			
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
NOVEMBER																									
Lymnaeidae					1		2	1							2	1									7
Physidae													1	4											5
																								TOTAL	12
DECEMBER																									
Lymnaeidae								1																	1
Physidae																									0
																								TOTAL	1

*The Order Mollusca was not present in Piceance Creek during January 1975.

**Station P-4 was relocated to P-5A in December 1974.

Table II-20. OLIGOCHAETA, HIRUDINEA, HOMOPTERA, HYDRACARINA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM PICEANCE CREEK DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975

Taxa	Station																								Total Number of Individuals
	P-1			P-2			P-3			P-4*			P-5			P-5A			P-6			P-7			
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
NOVEMBER																									
Oligochaeta	3	14	64	65	57	7	124	25	3		1					247	218	6	107			3	7	6	957
Hirudinea	1						2	6	1							2	1								13
Homoptera																						1			1
Hydracarina																									0
																								TOTAL	971
DECEMBER																									
Oligochaeta			6	23	30	86	10	24	4				4	10		4		4		6	6	1			218
Hirudinea																									0
Homoptera																									0
Hydracarina																									0
																								TOTAL	218
JANUARY																									
Oligochaeta	16		42												43	1		1	6	4	6	3	6		128
Hirudinea		1											2		1					1					5
Homoptera																									0
Hydracarina																									0
																								TOTAL	133

*Station P-4 was relocated to P-5A in December 1974.

Table II-21. NUMBER OF INDIVIDUALS AND SPECIES AT EACH BIOLOGICAL SAMPLING STATION FOR PICEANCE CREEK DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975

	Station																							
	P-1			P-2			P-3			P-4*			P-5			P-5A			P-6			P-7		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
NOVEMBER																								
Replicate Totals																								
Number of Individuals	203	94	202	82	73	15	179	107	27	24	7	13	63	229	44	330	263	21	115	0	0	8	13	13
Number of Species	12	8	10	5	6	6	13	14	9	5	5	4	10	8	7	10	8	4	4	0	0	3	3	3
Station Totals																								
Number of Individuals		499			170			313			44			336			614			115			21	
Number of Species		12			7			18			10			11			12			4			4	
DECEMBER																								
Replicate Totals																								
Number of Individuals	29	26	89	197	77	150	27	130	152				89	57	15	53	25	32	14	25	30	5	2	5
Number of Species	3	2	3	11	7	4	5	11	11				4	7	4	6	2	6	2	3	7	4	2	1
Station Totals																								
Number of Individuals		144			424			309						161			110			69			12	
Number of Species		4			11			15						8			8			8			5	
JANUARY																								
Replicate Totals																								
Number of Individuals	36	69	117	52	37	38	53	175	165				126	52	49	7	4	5	22	24	23	4	12	37
Number of Species	4	5	4	6	5	5	4	7	7				7	6	5	3	2	2	5	4	2	2	3	3
Station Totals																								
Number of Individuals		222			127			393						227			16			69			53	
Number of Species		6			9			7						10			3			6			4	

*Station P-4 was relocated to P-5A in December 1974.

Table II-22. DIPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM STEWART CREEK AND LAKES DURING NOVEMBER AND DECEMBER 1974 and JANUARY 1975

Taxa	Station												Total Number of Individuals
	S-1			S-2			SL-1*			SL-2			
	A	B	C	A	B	C	A	B	C	A	B	C	
NOVEMBER													
Chironomus		1		43	2	1				89			136
Simulium				125		2							127
Limnophora					1								1
Odontomyia													0
Dixa					1								1
Deuterophlegia													0
Rhagionidae				2									2
Tipulidae	1		2		1								4
Tabanidae													0
Ceratopogonidae				29									29
												TOTAL	300
DECEMBER													
Chironomus	6	14	10	8	16	8				397			459
Simulium	1	1		3	7	114							126
Limnophora		1		1		2							4
Odontomyia													0
Dixa													0
Deuterophlegia													0
Rhagionidae													0
Tipulidae													0
Tabanidae													0
Ceratopogonidae													0
												TOTAL	589

Table II-22 (Concluded)

Dixa	Station												Total Number of Individuals
	S-1			S-2			SL-1*			SL-2			
	A	B	C	A	B	C	A	B	C	A	B	C	
JANUARY													
Chironomus				10		3							13
Simulium				14	9	18							41
Limnophora													0
Odontomyia													0
Dixa													0
Deuterophlegia													0
Rhagionidae													0
Tipulidae				1		5							6
Tabanidae													0
Ceratopogonidae													0
												TOTAL	60

* Upper Stewart Lake was frozen over in December and January, 1974-75.

Table II-23. PLECOPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM STEWART CREEK AND LAKES DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975*

Taxa	Station												Total Number of Individuals
	S-1			S-2			SL-1			SL-2			
	A	B	C	A	B	C	A	B	C	A	B	C	
NOVEMBER													
Isoperla	1												1
Isogenus													0
Capniinae													0
Taeniopteryginae													0
												TOTAL	1
DECEMBER													
Isoperla													0
Isogenus													0
Capniinae		1											1
Taeniopteryginae													0
												TOTAL	1

* The Order Plecoptera was not present in Stewart Creek and Lakes during January 1975.

Table II-24. TRICHOPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM STEWART CREEK AND LAKES DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975*

Taxa	Station												Total Number of Individuals
	S-1			S-2			SL-1L.			SL-2			
	A	B	C	A	B	C	A	B	C	A	B	C	
DECEMBER													
Hydropsyche													0
Macronemum													0
Micrasema		1											1
Brachycentrus													0
Hydroptila													0
Psychomyia													0
												TOTAL	1
JANUARY													
Hydropsyche					1								1
Macronemum													0
Micrasema													0
Brachycentrus													0
Hydroptila													0
Psychomyia													0
												TOTAL	1

* The Order Trichoptera was not present during November 1974.

Table II-25. COLEOPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM STEWART CREEK AND LAKES DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975*

Taxa	Station												Total Number of Individuals
	S-1			S-2			SL-1**			SL-2			
	A	B	C	A	B	C	A	B	C	A	B	C	
NOVEMBER													
<u>Agabinus</u>							4						4
<u>Hydrophilinae</u>													0
<u>Helichus</u>													0
<u>Stenelmis</u>													0
<u>Heterlimnius</u>													0
<u>Hydroporus</u>													0
<u>Throscinus</u>													0
<u>Paracymus</u>					1								1
												TOTAL	5

* The Order Coleoptera was not present in December 1974 and January 1975.

** Upper Stewart Lake was frozen over in December 1974 and January 1975.

Table II-26. EPHEMEROPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM STEWART CREEK AND LAKES DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975

Taxa	Station												Total Number of Individuals
	S-1			S-2			SL-1*			SL-2			
	A	B	C	A	B	C	A	B	C	A	B	C	
NOVEMBER													
Baetis	2			6		1							9
Ephemerella						1							1
Pseudocloeon													0
Caenis													0
Ameletus					2		31			11			44
Heptagenia													0
Rhithrogena													0
Stenonema													0
												TOTAL	54
DECEMBER													
Baetis	3	12	2										17
Ephemerella													0
Pseudocloeon	1												1
Caenis													0
Ameletus				17	3	8				24			52
Heptagenia													0
Rhithrogena													0
Stenonema													0
												TOTAL	70

Table II-26. (Concluded)

Taxa	Station												Total Number of Individuals
	S-1			S-2			SL-1*			SL-2			
	A	B	C	A	B	C	A	B	C	A	B	C	
JANUARY													
<u>Baetis</u>					2								2
<u>Ephemerella</u>													0
<u>Pseudocloeon</u>													0
<u>Caenis</u>													0
<u>Ameletus</u>													0
<u>Heptagenia</u>													0
<u>Rhithrogena</u>													0
<u>Stenonema</u>													0
												TOTAL	2

* Upper Stewart Lake was frozen over in December 1974 and January 1975.

Table II-27. AMPHIPODA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM STEWART CREEK AND LAKES DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975

Taxa	Station												Total Number of Individuals
	S-1			S-2			SL-1*			SL-2			
	A	B	C	A	B	C	A	B	C	A	B	C	
NOVEMBER													
Gammarus				8	10	10							28
Hyalella													0
												TOTAL	28
DECEMBER													
Gammarus				2		14				5			21
Hyalella				18	10								28
												TOTAL	49
JANUARY													
Gammarus				11	4	6							21
Hyalella													0
												TOTAL	21

* Upper Stewart Lake was frozen in December 1974 and January 1975.

Table II-28. MOLLUSCA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM STEWART CREEK AND LAKES DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975*

Taxa	Station												Total Number of Individuals
	S-1			S-2			SL-1			SL-2			
	A	B	C	A	B	C	A	B	C	A	B	C	
NOVEMBER													
Lymnaeidae			1	15									16
Physidae					1								1
												TOTAL	17
DECEMBER													
Lymnaeidae				4									4
Physidae					1	1				7			9
												TOTAL	13

* The Order Mollusca was not present in Stewart Creek and Lakes during January 1975.

Table II-29. OLIGOCHAETA, HIRUDINEA, HOMOPTERA, HYDRACARINA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM STEWART CREEK AND LAKES DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975

Taxa	Station												Total Number of Individuals
	S-1			S-2			SL-1*			SL-2			
	A	B	C	A	B	C	A	B	C	A	B	C	
NOVEMBER													
Oligochaeta			12	115	24	2							153
Hirudinea				1									1
Homoptera													0
Hydracarina													0
												TOTAL	154
DECEMBER													
Oligochaeta		10		108	1	3				1			123
Hirudinea													0
Homoptera													0
Hydracarina													0
												TOTAL	123
JANUARY													
Oligochaeta													0
Hirudinea				14	1	5							20
Homoptera													0
Hydracarina													0
												TOTAL	20

* Upper Stewart Lake was frozen over in December 1974 and Janaury 1975.

Table II-30. NUMBER OF INDIVIDUALS AND SPECIES AT EACH BIOLOGICAL SAMPLING STATION FOR STEWART CREEK AND LAKES DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975

	Station											
	S-1			S-2			SL-1*			SL-2**		
	A	B	C	A	B	C	A	B	C	A	B	C
NOVEMBER												
Replicate Totals												
Number of Individuals	8	13	17	361	46	25	35	--	--	124	--	--
Number of Species	5	2	4	10	10	7	2	--	--	3	--	--
Station Totals												
Number of Individuals		38			432			37			127	
Number of Species		8			17			2			3	
DECEMBER												
Replicate Totals												
Number of Individuals	11	40	12	161	38	150	--	--	--	434	--	--
Number of Species	4	7	2	8	6	7	--	--	--	5	--	--
Station Totals												
Number of Individuals		63			349			--			434	
Number of Species		8			9			--			5	
JANUARY												
Replicate Totals												
Number of Individuals	--	--	--	50	17	37	--	--	--	--	--	--
Number of Species	--	--	--	5	5	5	--	--	--	--	--	--
Station Totals												
Number of Individuals		--			104			--			--	
Number of Species		--			7			--			--	

* Upper Stewart Lake was frozen over in December 1974 and January 1975.

** Weather conditions precluded taking samples.

Table II-31. DIPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM WILLOW CREEK AND LAKES DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975.

Taxa	Station W-1* A	W-1* B	W-1* C	W-2* A	W-2* B	W-2* C	W-3 A	W-3 B	W-3 C	WL-1 A	WL-1 B	WL-1 C	WL-2 A	WL-2 B	WL-2 C	Total Number of Individuals
NOVEMBER																
Chironomus	20	2	43	2	74	24	6	19	8	56			208			462
Simulium	64	55	94		1	2		6	2							224
Limnophora	2	5	8	1	3		1	4	2							26
Odontomyia																0
Dixa																0
Deuterophlegia																0
Rhagionidae								6								6
Tipulidae		1	1	7	5	3	15	16	10							58
Tabanidae					1			1								2
Ceratopogonidae								1								1
															TOTAL	779
DECEMBER																
Chironomus	7		1	9	3	4	3			26			18			71
Simulium	3		1	1		5	17	2	7							36
Limnophora	1	2	9	1					1							14
Odontomyia	3		4													7
Dixa																0
Deuterophlegia																0
Rhagionidae																0
Tipulidae	1	1	2	3		3			1							11
Tabanidae																0
Ceratopogonidae																0
															TOTAL	139

Table II-31 (Concluded)

Taxa	Station															Total Number of Individuals
	W-1			W-2			W-3			WL-1			WL-2			
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
JANUARY																
Chironomus							1	2	2							5
Simulium								5	4							9
Limnophora								1	1							2
Odontomyia																0
Dixa																0
Deuterophlegia																0
Rhagionidae																0
Tipulidae								2								2
Tabanidae																0
Ceratopogonidae																0
															TOTAL	18

* Willow Creek was frozen over in January 1975.

Table II-32. PLECOPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM WILLOW CREEK AND LAKES DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975

Taxa	Station W-1* A	B	C	W-2* A	B	C	W-3 A	B	C	WL-1 A	B	C	WL-2 A	B	C		Total Number of Individuals
NOVEMBER																	
Isoperla	3	7	1	1	5	3		2	1								23
Isogenus																	0
Capniinae																	0
Taeniopteryginae																	0
																TOTAL	23
DECEMBER																	
Isoperla	7	4	8	1	1	2			1								24
Isogenus																	0
Capniinae																	0
Taeniopteryginae																	0
																TOTAL	24
JANUARY																	
Isoperla									1								1
Isogenus																	0
Capniinae																	0
Taeniopteryginae																	0
																TOTAL	1

* Willow Creek was frozen over during January 1975.

Table II-33. TRICHOPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM WILLOW CREEK AND LAKES DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975

Taxa	Station W-1* A	W-1* B	W-1* C	W-2* A	W-2* B	W-2* C	W-3 A	W-3 B	W-3 C	WL-1 A	WL-1 B	WL-1 C	WL-2 A	WL-2 B	WL-2 C	Total Number of Individuals
NOVEMBER																
Hydropsyche			1													1
Macronemum						1										1
Micrasema								1								1
Brachycentrus																0
Hydroptila																0
Psychomyia																0
															TOTAL	3
DECEMBER																
Hydropsyche	1	2														3
Macronemum																0
Micrasema																0
Brachycentrus																0
Hydroptila																0
Psychomyia																0
															TOTAL	3
JANUARY																
Hydropsyche									1							1
Macronemum																0
Micrasema																0
Brachycentrus																0
Hydroptila																0
Psychomyia																0
															TOTAL	1

* Willow Creek was frozen over in January 1975.

Table II-34. COLEOPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM WILLOW CREEK AND LAKES DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975*

Taxa	Station															Total Number of Individuals
	W-1**			W-2**			W-3			WL-1			WL-2			
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
NOVEMBER																
Agabinus													1			1
Hydrophilinae							1									1
Helichus																0
Stenelmis																0
Heterlimnius			1													1
Hydroporus																0
Throscinus																0
Paracymus																0
															TOTAL	3
DECEMBER																
Agabinus													16			16
Hydrophilinae																0
Helichus	2															2
Stenelmis																0
Heterlimnius																0
Hydroporus																0
Throscinus			1													1
Paracymus																0
															TOTAL	19

* The Order Coleoptera was not found in Willow Creek and Lakes during January 1975.

** Willow Creek 1 & 2 were frozen over in January 1975.

Table II-35. EPHEMEROPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM WILLOW CREEK AND LAKES DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975*

Taxa	Station W-1			W-2			W-3			WL-1			WL-2			Total Number of Individuals
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
NOVEMBER																
Baetis	12	35			5	8		15	5							80
Ephemerella	2	1	4		2	1				136			7			153
Pseudocloeon	4		34		2			8								48
Caenis																0
Ameletus																0
Heptagenia																0
Rhithrogena																0
Stenonema																0
															TOTAL	281
DECEMBER																
Baetis	14		12	1		5	1	3	2							38
Ephemerella	1			2		1										4
Pseudocloeon																0
Caenis																0
Ameletus			1							15			14			30
Heptagenia																0
Rhithrogena																0
Stenonema																0
															TOTAL	72

Table II-35 (Concluded)

Taxa	Station															Total Number of Individuals
	W-1*			W-2*			W-3			WL-1			WL-2			
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
JANUARY																
Baetis							4	6	18							28
Ephemerella								1								1
Pseudocloeon																0
Caenis																0
Ameletus																0
Heptagenia																0
Rhithrogena																0
Stenonema																0
															TOTAL	29

* Willow Creek was frozen over in January 1975.

Table II-36. AMPHIPODA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM WILLOW CREEK AND LAKES DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975*

Taxa	Station															Total Number of Individuals
	W-1**			W-2**			W-3			WL-1			WL-2			
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
NOVEMBER																
Gammarus													4			4
Hyalella																0
															TOTAL	4
DECEMBER																
Gammarus													31			31
Hyalella										5						5
															TOTAL	36

* The Order Amphipoda was not found on Willow Creek during January 1975.

** Willow Creek was frozen over during January 1975.

Table II-37. MOLLUSCA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM WILLOW CREEK AND LAKES DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975*

Taxa	W-1**			W-2**			W-3			WL-1			WL-2			Total Number of Individuals
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
NOVEMBER																
Lymnaeidae	3		5		3					2						13
Physidae	9		47	1	17											73
															TOTAL	86
DECEMBER																
Lymnaeidae	1									1						2
Physidae																0
															TOTAL	2

* The Order Mollusca was not present in Willow Creek and lakes during January 1975.

** Willow Creek was frozen over in January 1975.

Table II-38. HEMIPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM WILLOW CREEK AND LAKES DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975*

Taxa	Station															Total Number of Individuals
	W-1			W-2			W-3			WL-1			WL-2			
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
DECEMBER																
Notonecta													1			1
															TOTAL	1

* The Order Hemiptera was not found in Willow Creek during November 1974 or January 1975.

Table II-39. OLIGOCHAETA, HIRUDINEA, HOMOPTERA, HYDRACARINA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM WILLOW CREEK AND LAKES DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975

Taxa	Station															Total Number of Individuals
	W-1*			W-2*			W-3			WL-1			WL-2			
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
NOVEMBER																
Oligochaeta	4	1	11	3	3	3		34	5							64
Hirudinea	2			1	1			3								7
Homoptera																0
Hydracarina			1													1
															TOTAL	72
DECEMBER																
Oligochaeta				1		2		5	1							9
Hirudinea																0
Homoptera																0
Hydracarina	1															1
															TOTAL	10
JANUARY																
Oligochaeta								2	29							31
Hirudinea									1							1
Homoptera																0
Hydracarina																0
															TOTAL	32

* Willow Creek was frozen over in January 1975.

Table II-40. NUMBER OF INDIVIDUALS AND SPECIES AT EACH BIOLOGICAL SAMPLING STATION FOR WILLOW CREEK AND LAKES DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975

	Station														
	W-1*			W-2*			W-3			WL-1**			WL-2**		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
NOVEMBER															
Replicate Totals															
Number of Individuals	125	106	251	17	122	45	23	116	33	194	--	--	220	--	--
Number of Species	11	8	13	7	13	8	4	13	7	3	--	--	4	--	--
Station Totals															
Number of Individuals		482			184			172			194			220	
Number of Species		15			14			14			3			4	
DECEMBER															
Replicate Totals															
Number of Individuals	42	9	39	19	4	22	21	10	13	47	--	--	80	--	--
Number of Species	12	4	9	8	2	7	3	3	6	4	--	--	5	--	--
Station Totals															
Number of Individuals		90			45			44			47			80	
Number of Species		14			8			7			4			5	
JANUARY															
Replicate Totals															
Number of Individuals	--	--	--	--	--	--	5	19	57	--	--	--	--	--	--
Number of Species	--	--	--	--	--	--	2	7	8	--	--	--	--	--	--
Station Totals															
Number of Individuals		--			--			81			--			--	
Number of Species		--			--			10			--			--	

* Stations 1 and 2 were frozen over in January 1975.

** Weather conditions precluded taking samples.

Table II-41. DIPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM THE WHITE RIVER DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975*

Taxa	Station						Total Number of Individuals
	WR-1			WR-2			
	A	B	C	A	B	C	
NOVEMBER							
Chironomus	3	7	34	86	384	25	539
Simulium		1	1	4	6		12
Limnophora							0
Odontomyia							0
Dixa							0
Deuterophlegia			1				1
Rhagionidae							0
Tipulidae					2		2
Tabanidae							0
Ceratopogonidae					6		6
						TOTAL	560
DECEMBER							
Chironomus	6	4	20	6	23	10	69
Simulium		1					1
Limnophora	1						1
Odontomyia							0
Dixa							0
Deuterophlegia							0
Rhagionidae							0
Tipulidae							0
Tabanidae							0
Ceratopogonidae					1		1
						TOTAL	72

* Weather conditions precluded taking samples in January 1975.

Table II-42. PLECOPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM THE WHITE RIVER DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975*

Taxa	Station						Total Number of Individuals
	WR-1			WR-2			
	A	B	C	A	B	C	
NOVEMBER							
Isoperla	7	3	35	15	21	10	91
Isogenus							0
Capniinae							0
Taeniopteryginae	6	6	22	40	63	18	155
						TOTAL	246
DECEMBER							
Isoperla	6	6	3	2	1	1	19
Isogenus							0
Capniinae							0
Taeniopteryginae	12	7	1		1		21
						TOTAL	40

* Weather conditions precluded taking samples in January 1975.

Table II-43. TRICHOPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM THE WHITE RIVER DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975*

Taxa	Station WR-1 A	Station WR-1 B	Station WR-1 C	Station WR-2 A	Station WR-2 B	Station WR-2 C	Total Number of Individuals
NOVEMBER							
Hydropsyche	1		12		4		17
Macronemum		1	6			1	8
Micrasema							0
Brachycentrus		1	3				4
Hydroptila		4	40	4	17		65
Psychomyia			1				1
						TOTAL	95
DECEMBER							
Hydropsyche	18	10	4			1	33
Macronemum							0
Micrasema							0
Brachycentrus							0
Hydroptila			2		1		3
Psychomyia							0
						TOTAL	36

* Weather conditions precluded taking samples in January 1975.

Table II-44. COLEOPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM THE WHITE RIVER DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975*

Taxa	Station WR-1 A	B	C	Station WR-2 A	B	C	Total Number of Individuals
NOVEMBER							
Agabinus							0
Hydrophilinae							0
Helichus							0
Stenelmis							0
Heterlimnius			1				1
Hydroporus							0
Throscinus							0
Paracymus							0
						TOTAL	1
DECEMBER							
Agabinus							0
Hydrophilinae							0
Helichus							0
Stenelmis							0
Heterlimnius	1						1
Hydroporus	2						2
Throscinus							0
Paracymus							0
						TOTAL	3

* Weather conditions precluded taking samples in January 1975.

Table II-45. EPHEMEROPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM THE WHITE RIVER DURING NOVEMBER AND DECEMBER 1974 AND JANUARY* 1975

Taxa	Station						Total Number of Individuals
	WR-1			WR-2			
	A	B	C	A	B	C	
NOVEMBER							
Baetis		6	148	64	117	12	347
Ephemerella	12	15	326	41	72	7	473
Pseudocloeon			37	14	47		98
Caenis		2	132	34	121		289
Ameletus							0
Heptagenia			7	1			8
Rhithrogena		5	22	2	7		36
Stenonema				1			1
						TOTAL	1,252
DECEMBER							
Baetis	23	15	28	11	12	12	101
Ephemerella	22	11	28	1	9	2	73
Pseudocloeon							0
Caenis			4		2		6
Ameletus							0
Heptagenia			1				1
Rhithrogena	11	10	1				22
Stenonema							0
						TOTAL	203

* Weather conditions precluded taking samples in January 1975.

Table II-46. ODONATA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM THE WHITE RIVER DURING NOVEMBER AND DECEMBER* 1974 AND JANUARY** 1975

Taxa	Station						Total Number of Individuals
	WR-1			WR-2			
	A	B	C	A	B	C	
NOVEMBER							
<u>Ischnura</u>							0
<u>Gomphus</u>			1		1		2
						TOTAL	2

* The Order Odonata was not found on the White River in December 1974.

** Weather conditions precluded taking samples.

Table II-47. OLIGOCHAETA, HIRUDINEA, HOMOPTERA, HYDRACARINA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM THE WHITE RIVER DURING NOVEMBER AND DECEMBER* 1974 AND JANUARY** 1975

Taxa	Station						Total Number of Individuals
	WR-1			WR-2			
	A	B	C	A	B	C	
NOVEMBER							
Oligochaeta				34	92	3	129
Hirudinea					1		1
Homoptera							0
Hydracarina							0
						TOTAL	130

* The orders above were not present in the White River during December 1974.

** Weather conditions precluded taking samples.

Table II-48. NUMBER OF INDIVIDUALS AND SPECIES AT EACH BIOLOGICAL SAMPLING STATION FOR WHITE RIVER DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975*

	Station					
	WR-1			WR-2		
	A	B	C	A	B	C
NOVEMBER						
Replicate Totals						
Number of Individuals	29	51	829	340	961	76
Number of Species	5	11	18	13	16	7
Station Totals						
Number of Individuals		909			1377	
Number of Species		18			19	
DECEMBER						
Replicate Totals						
Number of Individuals	102	64	92	20	50	26
Number of Species	10	8	10	4	8	5
Station Totals						
Number of Individuals		258			96	
Number of Species		14			9	

* Weather conditions precluded taking samples in January 1975.

one-way analysis-of-variance test" means that the difference in biomass observed probably represents a real and significant biological effect. This is because the probability (p) that at least this great a difference in biomass would occur simply by chance is less than 5 percent.

Trends in total individuals, total species, biomass, species diversity, and sample similarities are discussed below by sampling region: Piceance Creek, Stewart Creek, Willow Creek, and White River.

Piceance Creek. During November, December, and January, total individuals taken each month from all stations ranged from 21 to 614, 12 to 424, and 16 to 393, respectively (Table II-21). Stations P-6 and P-7 were consistently low in total numbers compared to the other Piceance Creek stations, while P-1, P-3, and P-5 were consistently high. The total number of individuals dropped during this time from 2068 individuals in November to 1107 in January.

Total species over the same period ranged from 4 to 18, 4 to 15, and 3 to 10 species for November, December, and January, respectively. The greatest number of species was collected at P-3, followed by P-2 and P-5. P-6 and P-7 supported the least number of species. Total species, summed over all stations, decreased from 68 in November to 45 in January. (These totals reflect species duplications in the summing over all stations.)

Generally, mean biomass decreased from November to December at each station and then increased in January (Tables II-49,-50, and-51). To determine statistically if a difference in biomass existed between stations and between months for the Piceance Creek stations, a Kruskal-Wallis analysis-of-variance test was applied to the data. The results (Table II-52) show that at p = 0.05 there is no difference in mean biomass between stations or between months. Because there was a general trend toward a decrease by month within stations, replicate biomass values were treated statistically within stations from month to month. The null hypothesis tested was that biomass within stations did not change significantly from month to

TABLE II-49. NOVEMBER: BIOMASS PER STATION, MEAN BIOMASS, AND STANDARD DEVIATION FOR PICEANCE CREEK, STEWART CREEK, WILLOW CREEK, AND THE WHITE RIVER

Station	Total[a] Biomass/ Station ($g/3ft^2$)	Mean[b] Biomass/ Station (gm/ft^2)	Standard Deviation
P-1	0.4175	0.1358	0.1077
P-2	0.1791	0.0597	0.0546
P-3	0.7009	0.2336	0.1927
P-4[c]	0.0509	0.0169	0.0083
P-5	0.3268	0.1089	0.1346
P-5A	1.0396	0.3465	0.3143
P-6	0.3353	0.1117	0.1180
P-7	0.0435	0.0145	0.0064
S-1	0.2119	0.0706	0.0957
S-2	0.2502	0.0834	0.0674
SL-1[d]	-	-	-
SL-2	0.1428[e]	-	-
W-1	1.1901	0.3967	0.2295
W-2	1.4414	0.4804	0.2198
W-3	1.8293	0.6097	0.1476
WL-1	0.9635[e]	-	-
WL-2	0.7538[e]	-	-
WR-1	0.1224	0.0408	0.0202
WR-2	0.9589	0.3184	0.1706

a Biomass summed over 3 replicate samples.
b Mean of 3 replicates.
c Station P-4 was eliminated in December 1974.
d Station was frozen over.
e Biomass given is for one sample.

TABLE II-50. DECEMBER: BIOMASS PER STATION, MEAN BIOMASS, AND STANDARD DEVIATION FOR PICEANCE CREEK, STEWART CREEK, WILLOW CREEK, AND THE WHITE RIVER

Station	Total[a] Biomass/ Station (g/3ft^2)	Mean[b] Biomass/ Station (g/ft^2)	Standard Deviation
P-1	0.0263	0.0087	0.004
P-2	0.6798	0.2266	0.100
P-3	0.4534	0.1501	0.050
P-5	0.0434	0.010	0.008
P-5A	0.0790	0.020	0.010
P-6	0.0319	0.010	0.008
P-7	0.0127	0.004	0.003
S-1	0.0809	0.020	0.010
S-2	0.7258	0.240	0.220
SL-1[c]	-	-	-
SL-2	0.2738[d]	-	-
W-1	0.3395	0.090	0.050
W-2	0.1416	0.040	0.050
W-3	0.0519	0.010	0.010
WL-1	0.6434[d]	-	-
WL-2	1.4670[d]	-	-
WR-1	0.3154	0.1000	0.050
WR-2	0.0978	0.030	0.010

a Biomass summed over 3 replicate samples.
b Mean of 3 replicates.
c Station was frozen over.
d Biomass given is for one sample.

TABLE II-51. JANUARY: BIOMASS PER STATION, MEAN BIOMASS, AND STANDARD DEVIATION FOR PICEANCE CREEK, STEWART CREEK, WILLOW CREEK, AND THE WHITE RIVER

Station	Total[a] Biomass/ Station (g/3ft^2)	Mean[b] Biomass/ Station (g/ft^2)	Standard Deviation
P-1	0.5486	0.1828	0.0643
P-2	0.3082	0.1027	0.0094
P-3	0.6708	0.2236	0.1237
P-5	0.0821	0.1178	0.0564
P-5A	0.0241	0.0080	0.0029
P-6	0.0850	0.0283	0.0229
P-7	0.0587	0.0195	0.0235
S-1[c]	-	-	-
S-2	0.6075	0.2025	0.2408
SL-1[d]	-	-	-
SL-2[c]	-	-	-
W-1[d]	-	-	-
W-2[d]	-	-	-
W-3	0.2309	0.0769	0.0684
SL-1[c]	-	-	-
SL-2[c]	-	-	-
WR-1[d]	-	-	-
WR-2[d]	-	-	-

a Biomass summed over 3 replicate samples.
b Mean of 3 replicates.
c Severe weather precluded taking samples.
d Stations were frozen over.

Table II-52. CALCULATED AND CRITICAL VALUES OF [a]STATISTICAL ANALYSES USED TO TEST NULL HYPOTHESES OF NO DIFFERENCE WITHIN AND BETWEEN STATIONS, AND BETWEEN MONTHS FOR BIOMASS AND SPECIES DIVERSITY INDICES: AND [b]SIMILARITY INDICES FOR REPLICATE SAMPLES WITHIN STATIONS DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975

	BIOMASS			SPECIES DIVERSITY			SIMILARITY INDICES								
							November			December			January		
Station	Calculated Value	Critical Value	Decision on Null	Calculated Value	Critical Value	Decision on Null	A-B	B-C	A-C	A-B	B-C	A-C	A-B	B-C	A-C
PICEANCE CREEK															
*P-1	5.60	$H_{.05,3,3,3} = 5.60$	Reject	0.68	$D_{.05,5} = 0.56$	Reject	.80	.89	.91	.40	.40	.33	.67	.67	1.00
*P-2	5.60	$H_{.05,3,3,3} = 5.60$	Reject	0.41	$D_{.05,5} = 0.56$	Accept	.91	.83	.91	.67	.55	.40	.73	.60	.55
*P-3	0.09	$H_{.05,3,3,3} = 5.60$	Accept	0.64	$D_{.05,5} = 0.56$	Reject	.74	.52	.46	.50	.45	.38	.73	.86	.73
*P-4	----	-----	----	0.56	$D_{.05,3} = 0.71$	Accept	.60	.67	.67	---	---	---	---	---	---
*P-5	5.60	$H_{.05,3,3,3} = 5.60$	Reject	0.79	$D_{.05,5} = 0.56$	Reject	1.00	.80	.82	.55	.55	.75	.62	.36	.67
*P-5A	4.36	$H_{.05,3,3,3} = 5.60$	Accept	0.12	$D_{.05,3} = 0.71$	Accept	.78	.50	.57	.50	.50	.83	.80	.50	.80
*P-6	2.22	$H_{.05,3,3,3} = 5.60$	Accept	0.58	$D_{.05,5} = 0.56$	Reject	0	0	0	.40	.60	.22	.67	.67	.57
*P-7	5.60	$H_{.05,3,3,3} = 5.60$	Reject	0.71	$D_{.05,5} = 0.56$	Reject	.67	1.00	.67	.40	.67	.40	.80	.67	.40
**Between Stations	8.44	$x^2_{.05,7} = 14.07$	Accept	18.79	$x^2_{.05,7} = 14.07$	Reject									
***Between Months	2.57	$x^2_{.05,2} = 5.99$	Accept	2.013	$x^2_{.05,4} = 9.49$	Accept									

a Kolmogorov - Smirnov One-Sample test (D)
Kruskal - Wallis One-Way Analysis of Variance (x^2 and H)
Mann - Whitney U Test (U)

b Soerensen's Index of Similarity $K = \frac{2j}{a+b}$

* H_0: There is no difference in Biomass/Species Diversity within a station between months.

** H_0: There is no difference in Biomass/Species Diversity between stations (for all months).

*** H_0: There is no difference in Biomass/Species Diversity between months (for all stations).

month. Table II-52 indicates that for P-1, P-2, P-5, and P-7, biomass did change significantly over the quarter; whereas at P-3, P-5A, and P-6 it did not.

Species diversity indices were calculated for each station during the months September through January (Table II-53), using the formula:

$$H' = -\sum_{i=1}^{s} p_i \log_2 p_i$$

where p_i is the proportion, p, of the i^{th} species in the sample, and s is the number of species.

Theoretically, the diversity index provides an estimate of the complexity of the biological community and reflects structural and organizational features which lend it overall stability. It is felt that the greater the number of species in a community, the more complex the energy flow pathways become. If any one pathway were eliminated, no great harm to the system would result since other similar energy pathways exist. The system thus maintains its stability. In a very simple community of few species, on the other hand, removing only one energy pathway could cause a loss of stability in the community.

The diversity index, H^1, has 2 components: (1) number of species, and (2) the proportion (evenness) of individuals among species, both of which increase diversity. Intuitively, one would accept that a sample of 10 species is more diverse than a sample of 2 species, therefore, H^1 would increase. The higher the H^1 value the greater the number of species, and/or evenness component and the more stable or complex the community. It also follows that low diversity may indicate a simple community or one suffering from some environmental perturbation.

Calculated species diversity indices for the Piceance Creek ranged from 0.67 at P-1 in December to 3.26 at P-5 in September. Wilhm (1970)

Table II-53. SPECIES DIVERSITY INDICES FOR PICEANCE CREEK

Month	Station							
	P-1	P-2	P-3	P-4*	P-5	P-5A*	P-6	P-7
September	1.66	2.08	2.59	2.75	3.26	----	1.44	1.00
October	1.49	1.59	2.05	1.36	2.40	----	1.59	1.19
November	2.21	1.40	2.47	2.46	2.20	1.29	0.44	1.42
December	0.67	1.47	2.37	----	2.12	1.16	2.02	1.84
January	1.76	1.82	1.58	----	2.35	1.06	1.27	1.76

* Station P-4 was relocated to P-5A.

reported that most clean-water streams he summarized ranged between 3 and 4. In four Colorado streams studied by Bingham (1968) diversity (H^1) ranged from 2.81 to 4.00. These data would suggest that the Piceance Creek is a marginal clean-water stream.

A Komolgorov-Smirnov one-sample test was used to determine if species diversity indices within stations were evenly distributed from month to month (i.e., species diversity is similar from month to month). Table II-52 presents critical values for the test and decisions on the null hypothesis; stations P-1, P-3, P-5, P-6, and P-7 showed significant differences in species diversity within stations during all sampling periods. A Kruskal-Wallis analysis-of-variance test applied to the data revealed that there was also a significant difference in species diversity between stations, but not between months.

These statistical results suggest that the differences in species diversity between stations and within stations reflect the temporal changes and the biological and physical differences in bottom communities along the Piceance Creek. This is to be expected, since stream and bottom conditions range from pools, riffles, and sandy bottoms to muddy substrate and standing water. However, these changes in species diversity noted within and between stations are not reflected between sampling periods. This fact suggests that the benthic communities are stable in terms of diversity on a temporal basis.

Soerensen's Index of Similarity was used to determine the similarity of replicate samples within each station. The number of species shared by each replicate is used to calculate a similarity index. These calculated values are presented in Table II-52. A value of 1.0 indicates complete similarity, while one of 0.0 indicates no similarity. No significance levels are attached to this index, but a value $\geq$0.650 is considered significant.

Similarity indices for replicate samples are useful in evaluating sampling efficiency. If, for example, the bottom fauna exists in a homogeneous environment, a high similarity between replicate samples can result. If, on the other hand, the bottom is heterogeneous and/or the organisms are distributed as patches or clumps of varying sizes, then the similarity between replicates would be expected to decrease. If an index ≤ 0.650 exists for all replicates, then this would suggest that more samples are needed for confidence that the majority of species had been sampled.

In November, P-3 and P-5A showed that replicates A and B were similar but C was not. All other stations were similar between replicates within a station. The December results show that very few replicates within stations were similar. This may result from seasonal qualitative changes in the fauna along Piceance Creek. The January indices were much improved, except for P-2.

Stewart Creek. Total numbers of individuals at all Stewart Creek stations for November, December, and January ranged from 37 to 432, 63 to 434, and 104 individuals, respectively (Table II-30). In January only station S-2 was sampled. Station S-2 was consistently high in total numbers of individuals, while S-1 was low. Because weather conditions were prohibitive during this quarter, upper and lower Stewart Lake stations could not be sampled effectively. The greatest number of individuals (846) were taken in December at S-2 and SL-2. Over all sampling periods, S-2 had 885 individuals while SL-2 had 561. S-1 and SL-1 had 101 and 37 individuals respectively.

Total species, summed over all stations, fell from a high of 33 in November to a low of 7 in January. Because sampling was difficult

and not complete during this quarter, these numbers may not be significant. Within a sampling period the greatest range in species (2-17) occurred in November.

Mean biomass values fell in December for S-1 but increased for S-2. A lack of samples, however, precludes describing trends. To determine if statistical differences existed in biomass values between stations over all months, and between months over all stations, a Kruskal-Wallis analysis-of-variance and a Mann-Whitney U test were applied to the data. These results, shown in Table II-54, suggest that no significant differences exist; that is, biomass between stations is similar, as is biomass between months.

Species diversity indices for the Stewart Creek stations are presented in Table II-55; they range from 0.49 at SL-2 in November to 2.43 at S-1 in October. These ranges fall below those cited by Bingham (1968) for some Colorado streams.

Several tests were applied to the species diversity indices to determine if differences existed between stations or months, or within stations. These results (Table II-54) show that there is a difference between stations but not between months. Only SL-1 showed a difference in species diversity from month to month. A difference between stations along Stewart Creek could be expected since two stations are lakes and two are streams; species numbers and abundances differ in these two habitats. As with Piceance Creek, the month-to-month changes in species diversity over all stations is not significant. This implies temporal stability along Stewart Creek.

Similarity indices (Table II-54) for Stewart Creek are lacking due to incomplete field sampling. In general, however, replicate samples are not

Table II-54. CALCULATED AND CRITICAL VALUES OF [a]STATISTICAL ANALYSES USED TO TEST NULL HYPOTHESES OF NO DIFFERENCE WITHIN AND BETWEEN STATIONS, AND BETWEEN MONTHS FOR BIOMASS AND SPECIES DIVERSITY INDICES: AND [b]SIMILARITY INDICES FOR REPLICATE SAMPLES WITHIN STATIONS DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975

	BIOMASS			SPECIES DIVERSITY			SIMILARITY INDICES November			December			January		
Station	Calculated Value	Critical Value	Decision on Null	Calculated Value	Critical Value	Decision on Null	A-B	B-C	A-C	A-B	B-C	A-C	A-B	B-C	A-C
STEWART CREEK															
*S-1	4.00	$U_{.10,3,3} = 9$	Accept	0.37	$D_{.05,4} = 0.62$	Accept	0	0	.22	.55	.44	.67	---	---	---
*S-2	1.42	$H_{.05,3,3,3} = 5.6$	Accept	0.34	$D_{.05,5} = 0.56$	Accept	.30	.35	.59	.71	.77	.80	.60	.60	1.00
*SL-1	----	-----	----	0.94	$D_{.05,3} = 0.71$	Reject	---	---	---	---	---	---	---	---	---
*SL-2	----	-----	----	0.39	$D_{.05,4}$ 0.62	Accept	---	---	---	---	---	---	---	---	---
**Between Stations	41.00	$U_{.05,9,6} = 44.00$	Accept	11.36	$x^2_{.05,3} = 7.82$	Reject									
***Between Months	0.60	$x^2_{.05,2} = 5.99$	Accept	1.85	$x^2_{.05,4} = 9.49$	Accept									

a Kolmogorov - Smirnov One-Sample Test (D)
Kruskal - Wallis One-Way Analysis of Variance (x^2 and H)
Mann - Whitney U Test (U)

b Soerensen's Index of Similarity $K = \frac{2j}{a+b}$

* H_o: There is no difference in Biomass/Species Diversity within a station between months.

** H_o: There is no difference in Biomass/Species Diversity between stations (for all months).

*** H_o: There is no difference in Biomass/Species Diversity between months (for all stations).

Table II-55. SPECIES DIVERSITY INDICES FOR STEWART CREEK AND LAKES

Month	Station S-1	S-2	SL-1	SL-2
September	1.65	2.00	1.95	0.41
October	2.43	2.10	0.58	1.40
November	2.02	2.44	0.51	0.49
December	1.98	2.34	*	0.54
January	**	2.24	*	**

* Station was frozen over.

** Weather conditions precluded taking samples.

similar at S-1 and S-2 for November, at S-1 for December, and S-2 for January.

Willow Creek. Willow Creek was not sampled at all stations during this quarter, so trends may be misleading. For example, in November and December W-1 had more total individuals (482) than any other station, but the totals for WL-1 and WL-2 represent only one sample (see Table II-40). January totals are too incomplete for any meaningful comparisons. It is apparent, however, that W-1, W-2, and W-3 have more species than the lake stations, but they may not support more total individuals.

At W-1, W-2, and W-3 mean biomass dropped significantly from November to December. During November, biomass averaged 1.43 g/ft^2, while in December the average was 0.18 g/ft^2.

The Mann-Whitney U test determined that significant differences existed within a station from month to month (Table II-56), while the Komolgorov-Smirnov test showed significant differences in biomass between months for all stations. However, no significant differences were detected between stations. These results suggest that temporal changes in biomass apply to all stations equally.

Species diversity indices for the Willow Creek stations ranged from 0.38 at WL-2 in November to 3.02 at W-1 in December (Table II-57). Significant temporal changes in species diversity occurred at W-1 and W-3. A greater change might be expected at a stream station than at a lake station because the former is more susceptible to perturbations than the latter. This is what Table II-56 suggests. Taking all stations as a whole, there is no significant temporal change in diversity. Taking all months as a whole, there are significant differences in diversity between stations. Differences between stations suggest biological/habitat differences not associated with seasonal conditions.

Similarity indices for W-1, W-2, and W-3 are presented in Table II-57. Similarity between replicates for each station was high in

Table II-56. CALCULATED AND CRITICAL VALUES OF [a]STATISTICAL ANALYSES USED TO TEST NULL HYPOTHESES OF NO DIFFERENCE WITHIN AND BETWEEN STATIONS, AND BETWEEN MONTHS FOR BIOMASS AND SPECIES DIVERSITY INDICES: AND [b]SIMILARITY INDICES FOR REPLICATE SAMPLES WITHIN STATIONS DURING NOVEMBER AND DECEMBER 1974 AND JANUARY 1975

	BIOMASS			SPECIES DIVERSITY			SIMILARITY INDICES								
							November			December			January		
Station	Calculated Value	Critical Value	Decision on Null	Calculated Value	Critical Value	Decision on Null	A-B	B-C	A-C	A-B	B-C	A-C	A-B	B-C	A-C
WILLOW CREEK															
*W-1	7.00	U.10,3,3 = 9	Accept	0.76	D.05,4 = 0.62	Reject	.74	.67	.75	.50	.46	.67	---	---	---
*W-2	9.00	U.10,3,3 = 9	Reject	0.61	D.05,4 = 0.62	Accept	1.00	.95	.80	.40	.44	.93	---	---	---
*W-3	5.60	H.05,3,3,3 = 5.6	Reject	1.10	D.05,5 = 0.56	Reject	.71	.70	.55	.67	.67	.44	.44	.40	.40
*WL-1	----	-----	----	0.21	D.05,4 = 0.62	Accept	---	---	---	---	---	---	---	---	---
*WL-2	----	-----	----	0.81	D.05,2 = 0.84	Accept	---	---	---	---	---	---	---	---	---
**Between Stations	0.52	x^2 .05,2 = 5.99	Accept	10.30	x^2 .05,4 = 9.49	Reject									
***Between Months	13.17	x^2 .05,2 = 5.99	Reject	1.11	x^2 .05,4 = 9.49	Accept									
WHITE RIVER															
*WR-1	3.00	U.10,3,3 = 9	Accept	1.08	D.05,4 = 0.62	Reject	.50	.76	.44	.78	.78	.70	---	---	---
*WR-2	9.00	U.10,3,3 = 9	Reject	0.64	D.05,4 = 0.62	Reject	.76	.52	.60	.67	.62	.89	---	---	---
**Between Stations	22.00	U.05,6,6 = 31	Accept	10.00	U.05,4,4 = 16	Accept									
***Between Months	25.00	U.05,6,6 = 31	Accept	0.86	D.05,4 = 0.62	Reject									

a Kolmogorov - Smirnov One-Sample test (D)
Kruskal - Wallis One-Way Analysis of Variance (x^2 and H)
Mann - Whitney U Test

b Soerensen's Index of Similarity $K = \frac{2j}{a+b}$

* H_o: There is no difference in Biomass/Species Diversity within a station between months.

** H_o: There is no difference in Biomass/Species Diversity between stations (for all months).

*** H_o: There is no difference in Biomass/Species Diversity between months (for all stations).

Table II-57. SPECIES DIVERSITY INDICES FOR WILLOW CREEK AND LAKE

Month	Station W-1	W-2	W-3	U.W.L.	L.W.L.
September	1.95	3.29	1.22	1.34	***
October	2.19	2.31	1.74	1.33	***
November	2.64	2.45	2.99	0.87	0.38
December	3.02	2.65	1.87	1.46	1.99
January	*	*	2.34	**	**

* Stations were frozen over.

** Weather conditions precluded taking samples.

*** Station WL-2 started in November 1974.

November but fell in December. This may reflect both qualitative and quantitative changes in the benthos on a monthly basis.

White River. The White River stations were not sampled in January because of bad weather. Trends in individuals and species numbers refer to November and December only and may not be significant. Total individuals were greatest at WR-1 for the quarter, and in November for any one month. Total species trends were identical to total individual trends.

Species diversity indices ranged from 1.75 at WR-1 in October to 2.88 at WR-1 and WR-2 in December and November respectively (Table II-58). Statistical results indicate that species diversity changed temporarily within stations and between the months from September to December (Table II-54). These changes were not significant between stations for all months. In other words, species diversity reflects seasonal events in the biological environment of all stations.

Similarity of replicates was low for both White River stations in November, but was acceptable in December (Table II-54). This suggests that the November bottom fauna was more heterogeneous or patchy or both than in December, assuming that samples were taken in the same locations.

To summarize generally, total individuals, total species, biomass and species diversity changed temporally within a station at several sampling locations. Between stations, however, there was no change in biomass values. Only the Willow Creek stations showed a significant change in biomass between months. Statistical treatments of species diversity values are very similar to the biomass values. Generally, species diversity changed significantly within a station from month to month and between stations over all months throughout the basin, except at the Stewart Creek stations. However, when all stations are taken together, only the White River shows significant month-to-month change.

Table II-58. SPECIES DIVERSITY INDICES FOR THE WHITE RIVER

Month	Station WR-1	WR-2
September	1.79	1.79
October	1.75	1.83
November	2.82	2.88
December	2.88	2.02
January	*----	*----

* Stations were frozen over.

Similarity indices suggest that three replicate samples are sufficient to characterize the bottom community at some stations.

A healthy community is theoretically a stable community; and stability is reflected in the diversity index. Statistical results suggest that during the period September to January species diversity values were stable except along the White River.

Periphyton

Periphyton is the assemblage of microscopic plants and invertebrates that cover the stream substrate. Periphyton collected from glass slides have been analyzed for species composition and biomass. Table II-59 lists the genera of periphyton found on the samplers to date. Because of the ice covering and vandalism, the number of stations sampled in January was greatly reduced. The periphyton samplers were removed from the streams in January and will be replaced during the March sampling period.

The occurrence distributions of periphyton genera collected from the submerged samplers are presented in Tables II-60 through II-64. Since it is generally assumed that higher quality habitats have a greater or more diverse number of species, the total number of genera collected at each station were compared with one another. Figure II-6 displays the number of genera collected at each station over the 5-month period to date.

Complete comparisons between stations cannot be made because not all stations were sampled for the entire period. The downstream stations on Piceance Creek and the stations on the White River could not be sampled in December and January because ice covered the samplers.

From the data available, it can be noted that the stations on Willow Creek and the White River generally have the highest number of different genera of periphyton. The stations along Piceance Creek appear to be

Table II-59. LIST OF GENERA OF PERIPHYTON COLLECTED FROM PICEANCE CREEK, WILLOW CREEK, STEWART CREEK, AND THE WHITE RIVER, SEPTEMBER - DECEMBER 1974 AND JANUARY 1975

SCIENTIFIC NAME	COMMON NAME
Chlorophyceae	Green Algae
Pediastrum	
Scenedesmus	
Actinastrum	
Closterium	
Cosmarium	
Spirogyra	
Ulothrix	
Microspora	
Chaetophora	
Stigoclonium	
Protococcus	
Enteromorpha	
Cladophora	
Vaucheria	
Bacillariophyceae	Diatoms
Melosira	
Cyclotella	
Tabellaria	
Meridion	
Diatoma	
Asterionella	
Ceratoneis	
Fragilaria	
Synedra	
Eunotia	

Table II-59 (Concluded)

SCIENTIFIC NAME	COMMON NAME
Cocconeis	
Achnanthes	
Rhoicosphaenia	
Caloneis	
Deploneis	
Frustulia	
Gyrosigma	
Navicula	
Nedium	
Pinnularia	
Stauroneis	
Gomphonema	
Gomphoneis	
Cymbella	
Amphora	
Rhopalodia	
Nitzschia	
Cymatophleura	
Sirurella	
Cyanophyta	Blue-green algae
Agmenellum	
Nodularia	
Anabaena	
Lyngbya	
Phormidium	

*Identifications:

(1) Smith, G. M. 1950. The fresh-water algae of the United States. 2nd ed. McGraw-Hill Book Co., New York.

(2) Ward, H. B., and G. C. Whipple. 1965. Fresh-water biology, 2nd ed. Edited by W. T. Edmondson. Wiley and Sons, New York.

Table II-60. DISTRIBUTION OF PERIPHYTON GENERA COLLECTED FROM PICEANCE CREEK, WILLOW CREEK, STEWART CREEK, AND THE WHITE RIVER, SEPTEMBER 1974

Station	Chlorophyceae	Pediastrum	Scenedesmus	Actinastrum	Closterium	Cosmarium	Spirogyra	Ulothrix	Microspora	Chaetophora	Stigoclonium	Protococcus	Enteromorpha	Cladophora	Vaucheria
P-1															
P-2			x											x	
P-3															
P-5A		x												x	
P-6														x	
P-7															
WR-1								x							
WR-2				x		x									
W-1									x				x	x	x
W-3							x						x	x	
S-1															
S-2		x		x					x			x			

Station	Bacillariophyceae	Melosira	Cyclotella	Tabellaria	Medidion	Diatoma	Asterionella	Ceratoneis	Fragilaria	Synedra	Eunotia	Cocconeis	Achnanthes	Rhoicosphenia	Caloneis	Diploneis
P-1						x			x			x		x		
P-2				x	x	x				x		x		x	x	
P-3				x					x	x				x	x	
P-5A					x	x			x	x		x			x	x
P-6					x	x				x		x			x	x
P-7																
WR-1			x		x	x	x		x	x	x	x				
WR-2						x			x	x		x		x	x	
W-1				x		x		x	x	x		x		x		
W-3			x	x	x	x	x		x	x		x		x		x
S-1				x						x		x				
S-2			x	x	x	x			x	x		x		x		

Station	Frustulia	Gyrosigma	Navicula	Nedium	Pinnularia	Stauroneis	Gomphonema	Gomphoneis	Cymbella	Amphora	Rhopalodia	Nitzschia	Cymatopleura	Sirurella	Cyanophyta	Agmenellum	Nodularia	Anabaena	Lyngbya	Phormidium
P-1	x		x				x			x										
P-2	x	x	x				x			x		x		x						
P-3	x	x	x				x		x	x		x		x						
P-5A	x	x	x				x		x			x		x						
P-6	x	x	x				x		x			x		x						
P-7																				
WR-1	x	x	x		x		x		x	x		x		x		x				x
WR-2	x	x	x			x	x			x	x	x		x						
W-1	x	x	x						x			x		x		x				
W-3	x	x	x				x		x	x		x		x					x	
S-1	x		x				x		x			x								
S-2	x	x	x				x			x		x		x						x

Table II-61. DISTRIBUTION OF PERIPHYTON GENERA COLLECTED FROM PICEANCE CREEK, WILLOW CREEK, STEWART CREEK AND THE WHITE RIVER, OCTOBER 1974

Station	Chlorophyceae	Pediastrum	Scenedesmus	Actinastrum	Closterium	Cosmarium	Spirogyra	Ulothrix	Microspora	Chaetophora	Stigoclonium	Protococcus	Enteromorpha	Cladophora	Vaucheria
P-1					x										
P-2													x		
P-3			x												
P-5A				x									x		
P-6				x											
P-7				x											
WR-1								x							
WR-2															
W-1															
W-3				x				x							
S-1				x						x					
S-2				x											

Station	Bacillariophyceae	Melosira	Cyclotella	Tabellaria	Medidion	Diatoma	Asterionella	Ceratoneis	Fragilaria	Synedra	Eunotia	Cocconeis	Achnanthes	Rhoicosphenia	Caloneis	Diploneis	Frustulia	Gyrosigma	Navicula	Nedium	Pinnularia	Stauroneis	Gomphonema	Gomphoneis	Cymbella	Amphora	Rhopalodia	Nitzschia	Cymatopleura	Sirurella
P-1					x					x		x			x		x	x	x			x	x		x			x	x	x
P-2				x	x	x				x		x					x	x	x				x			x		x		x
P-3				x						x		x		x	x		x	x	x				x	x	x	x				x
P-5A				x		x			x					x	x		x	x	x							x		x		x
P-6				x								x			x		x	x	x		x				x		x	x	x	x
P-7				x						x		x			x		x	x	x				x			x		x		x
WR-1				x	x	x			x	x		x		x	x		x	x	x				x		x	x	x	x		x
WR-2				x					x	x		x		x	x		x	x	x				x	x	x	x	x			x
W-1				x		x			x			x		x			x	x	x		x		x					x		x
W-3				x					x			x		x			x		x				x			x		x		x
S-1				x	x				x			x					x	x	x				x		x			x		x
S-2									x	x		x			x		x	x	x		x		x			x		x		x

Station	Cyanophyta	Agmenellum	Nodularia	Anabaena	Lyngbya	Phormidium
P-1						
P-2						
P-3						x
P-5A						
P-6				x		
P-7						
WR-1						
WR-2						
W-1						
W-3						
S-1						
S-2						

Table II-62. DISTRIBUTION OF PERIPHYTON GENERA COLLECTED FROM PICEANCE CREEK, WILLOW CREEK, STEWART CREEK, AND THE WHITE RIVER, NOVEMBER 1974

Station	Chlorophyceae	Pediastrum	Scenedesmus	Actinastrum	Closterium	Cosmarium	Spirogyra	Ulothrix	Microspora	Chaetophora	Stigeoclonium	Protococcus	Enteromorpha	Cladophora	Vaucheria
P-1				x											
P-2															
P-3					x						x				x
P-5A				x											
P-6				x										x	
P-7															
WR-1						x	x	x			x			x	
WR-2					x			x							
W-1									x					x	x
W-3				x											
S-1				x											
S-2				x											

Station	Bacillariophyceae	Melosira	Cyclotella	Tabellaria	Medidion	Diatoma	Asterionella	Ceratoneis	Fragilaria	Synedra	Eunctia	Cocconeis	Achnanthes	Rhoicosphenia	Caloneis	Diploneis	Frustulia	Gyrosigma	Navicula	Nedium	Pinnularia	Stauroneis	Gomphonema	Gomphoneis	Cymbella	Amphora	Rhopalodia	Nitzschia	Cymatopleura	Sirurella
P-1				x	x					x		x					x		x		x	x	x		x	x		x	x	x
P-2				x	x					x		x			x		x		x			x			x	x	x	x	x	
P-3				x		x			x	x		x					x	x	x			x	x			x		x	x	x
P-5A				x						x		x	x		x		x		x			x	x			x		x		x
P-6				x						x		x	x		x		x	x	x	x	x		x					x		x
P-7												x					x		x							x		x		
WR-1				x				x		x		x			x			x	x		x	x	x		x	x		x		
WR-2				x	x	x		x		x		x		x			x	x	x		x		x	x	x	x		x	x	
W-1				x	x				x	x		x		x	x		x	x	x		x	x			x	x		x		x
W-3				x	x				x	x		x					x	x	x	x	x					x		x	x	x
S-1				x	x							x						x	x			x	x			x	x	x		x
S-2										x		x							x		x	x	x							x

Station	Cyanophyta	Agmenellum	Nodularia	Anabaena	Lyngbya	Phormidium
P-1						
P-2						
P-3						
P-5A						
P-6						
P-7						
WR-1						
WR-2						
W-1						
W-3						
S-1						
S-2						

Table II-63. DISTRIBUTION OF PERIPHYTON GENERA COLLECTED FROM PICEANCE CREEK, WILLOW CREEK, STEWART CREEK, AND THE WHITE RIVER, DECEMBER 1974

Station	Chlorophyceae	Pediastrum	Scenedesmus	Actinastrum	Closterium	Cosmarium	Spirogyra	Ulothrix	Microspora	Chaetophora	Stigoclonium	Protococcus	Enteromorpha	Cladophora	Vaucheria
P-1															x
P-2															
P-3															
P-5A															
P-6															
P-7															
WR-1															
WR-2															
W-1															
W-3															
S-1															
S-2															

Station	Bacillariophyceae	Melosira	Cyclotella	Tabellaria	Meridion	Diatoma	Asterionella	Ceratoneis	Fragilaria	Synedra	Eunotia	Cocconeis	Achnanthes	Rhoicosphenia	Caloneis	Diploneis	Frustulia	Gyrosigma	Navicula	Nedium	Pinnularia	Stauroneis	Gomphonema	Gomphoneis	Cymbella	Amphora	Rhopalodia	Nitzschia	Cymatopleura	Sirurella
P-1				x		x				x		x			x		x		x	x		x	x			x		x		x
P-2				x	x	x			x	x							x	x	x			x	x			x		x		x
P-3																														
P-5A					x				x	x		x						x	x						x					x
P-6																														
P-7																														
WR-1																														
WR-2																														
W-1																														
W-3					x				x	x		x					x		x		x	x				x				
S-1				x	x	x			x	x		x		x					x			x	x			x		x		
S-2					x	x			x					x			x		x			x	x			x		x		x

Station	Cyanophyta	Agmenellum	Nodularia	Anabaena	Lyngbya	Phormidium
P-1						
P-2						
P-3						
P-5A						
P-6						
P-7						
WR-1						
WR-2						
W-1						
W-3						
S-1			x			
S-2						

Table II-64. DISTRIBUTION OF PERIPHYTON GENERA COLLECTED FROM PICEANCE CREEK, WILLOW CREEK, STEWART CREEK, AND THE WHITE RIVER, JANUARY 1975

Station	Chlorophyceae	Pediastrum	Scenedesmus	Actinastrum	Closterium	Cosmarium	Spirogyra	Ulothrix	Microspora	Chaetophora	Stigoclonium	Protococcus	Enteromorpha	Cladophora	Vaucheria
P-1															
P-2									X					X	
P-3															
P-5A				X											
P-6															
P-7															
WR-1															
WR-2															
W-1															
W-3															
S-1									X						
S-2															

Station	Bacillariophyceae	Melosira	Cyclotella	Tabellaria	Meridion	Diatoma	Asterionella	Ceratoneis	Fragilaria	Synedra	Eunotia	Cocconeis	Achnanthes
P-1													
P-2				X		X			X	X		X	
P-3													
P-5A													
P-6													
P-7													
WR-1													
WR-2													
W-1													
W-3				X	X					X			
S-1				X			X		X	X		X	
S-2				X	X							X	X

Station	Rhoicosphenia	Caloneis	Diploneis	Frustulia	Gyrosigma	Navicula	Nedia	Pinnularia	Stauroneis	Gomphonema	Gomphoneis	Cymbella	Amphora	Rhopalodia	Nitzschia	Cymatopleura	Sirurella
P-1																	
P-2				X	X	X		X			X	X			X		X
P-3																	
P-5A	X			X		X			X			X					
P-6																	
P-7																	
WR-1																	
WR-2																	
W-1																	
W-3	X				X	X			X								
S-1	X			X	X	X		X	X	X		X			X		X
S-2					X	X			X	X		X			X		

Station	Cyanophyta	Agmenellum	Nodularia	Anabaena	Lyngbya	Phormidium
P-1						
P-2					X	
P-3						
P-5A						
P-6						
P-7						
WR-1						
WR-2						
W-1						
W-3						
S-1						
S-2						

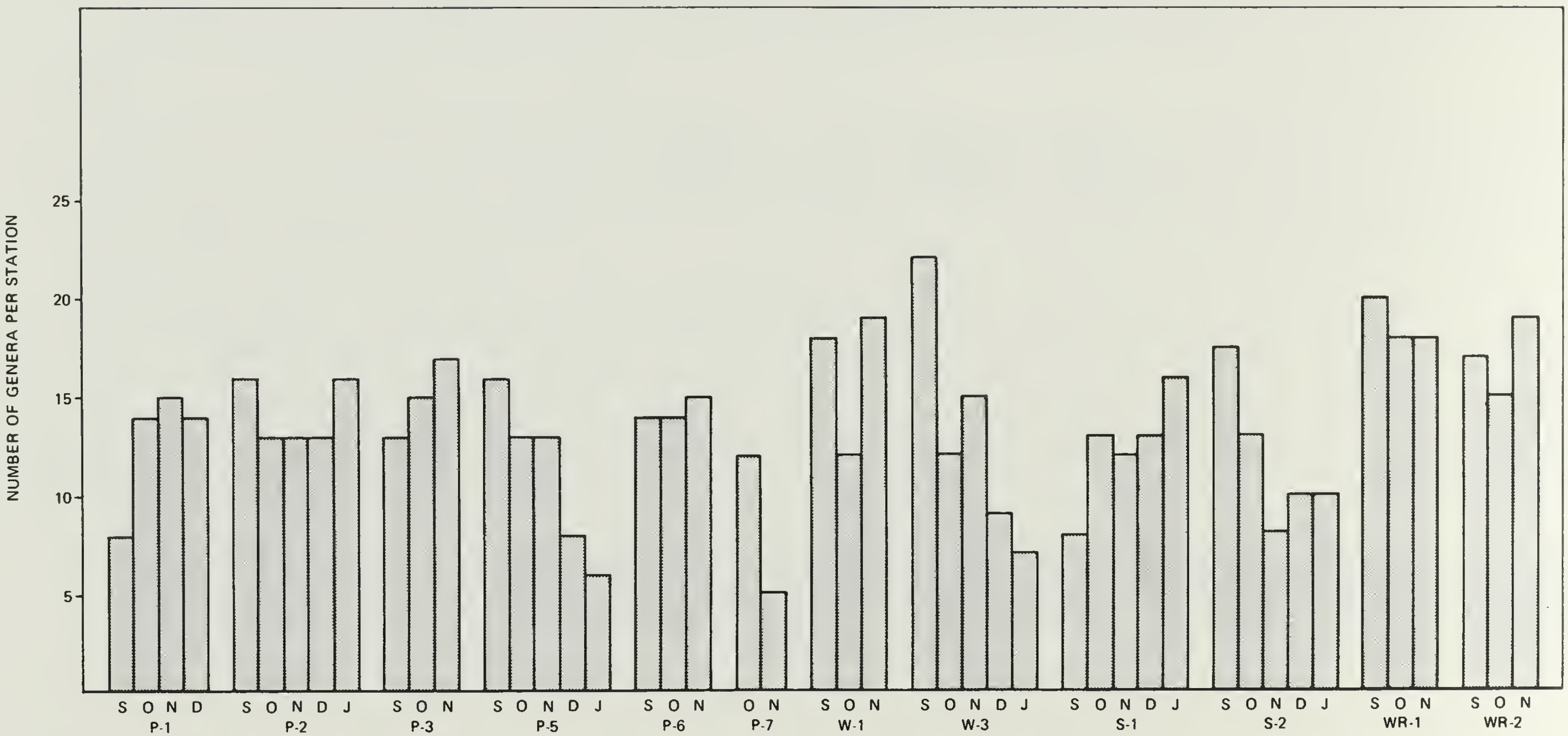

Figure II-6. MONTHLY ABUNDANCE OF PERIPHYTON GENERA AT EACH STATION, SEPTEMBER - DECEMBER 1974 AND JANUARY 1975

similar in the number of genera collected during any given month. Station P-7, although only 2 months' data are shown, appears to be the least productive in terms of genera collected.

Seasonal changes in the number of genera collected are difficult to discern. Five stations showed a general decrease in numbers of genera collected, while five stations showed the opposite trend. The greatest number of genera (22) collected in any month occurred in September at Station W-3; while the least number of genera (6) at any station other than P-7 occurred in January at P-5.

Biomass. Estimates of the mean biomass of periphyton per square meter were made based on the weight of periphyton collected from the stream samplers. These estimates are shown in Table II-65. The biomass estimates present some interesting figures. Three stations, all on Piceance Creek, appear to have the greatest biomass per unit area — P-1, P-3, and P-5. Stations P-2 and W-1 also have relatively high biomass estimates. The highest estimate was 84.4 gm/m^2 at station P-5, while the lowest estimate was 0.62 gm/m^2 at station S-1 in October.

Seasonal changes are quite evident, as might be expected. With decreasing amounts of sunlight and lower temperatures, periphyton production should decrease. Eight of the twelve stations sampled showed decreased biomass estimates as winter approached. The seasonal decrease is especially evident along Piceance Creek. In Willow Creek and Stewart Creek, the periphyton biomass estimates actually increased in most cases. Along these creeks, dense shrubs and overhanging grasses obscure the streambed and block out sunlight. During late fall, when most of the riparian vegetation has died, the periphyton growth may be aided by increased sunlight penetration. In general, the greatest number of species did not correspond with the greatest estimate of biomass. The data indicate that Piceance Creek, although slightly lower in species diversity, had the greatest estimates of periphyton biomass.

Table II-65. ESTIMATES OF PERIPHYTON MEAN BIOMASS (gm/m^2) BASED ON THREE REPLICATE SAMPLES AT EACH STATION FOR SEPTEMBER, OCTOBER AND NOVEMBER 1974

MONTH	STATION											
	P-1	P-2	P-3	P-5	P-6	P-7	W-1	W-3	WR-1	WR-2	S-1	S-2
September												
$\bar{X}^a$	0.102	0.0767	0.1006	0.1633	0.0368	- -	0.0199	0.0029	0.386	0.0164	0.0018	0.0092
S.D.	0.0161	0.0070	0.0156	0.0119	0.0644	- -	0.0355	0.0003	0.0322	0.0170	0.0018	0.0012
gm/m^2	52.71	39.64	51.99	84.39	19.02	- -	10.28	1.50	19.95	8.48	0.93	4.75
October												
$\bar{X}^a$	0.0977	0.0203	0.0492	0.0868	0.0005	0.0348	0.0096	0.0055	- -	- -	0.0012	0.0040
S.D.	0.0057	0.0050	0.0033	0.0057	0.0002	0.0046	0.0041	0.0026	- -	- -	0.0002	0.0018
gm/m^2	50.49	10.51	25.43	44.84	0.2756	17.98	4.96	2.84	- -	- -	0.6202	2.07
November												
$\bar{X}^a$	0.0516	0.0084	0.0471	0.0046	0.0240	0.0161	0.0519	0.0269	0.0112	0.0091	0.0057	0.0029
S.D.	0.0066	0.0024	0.0013	0.0026	0.0093	0.0226	0.0070	0.0098	0.0136	0.0070	0.0032	0.0017
gm/m^2	26.67	4.34	24.34	2.36	12.42	8.30	26.82	13.90	5.79	4.70	2.93	1.50

a: Mean value for three replicate samples at each station. Total weight (grams).

Willow Creek and the White River are similar in the estimates of periphyton biomass, while Stewart Creek has been the least productive in terms of periphyton biomass.

In all cases, it should be emphasized that the periphyton biomass estimates represent an estimate of standing crop, or accumulated production, over the month-long period that the samplers are submerged in the streams.

Water Quality

The chemical analyses presented in Tables II-66 through II-73 were done by Environmental Engineering Laboratory, San Diego. Analyses performed included measurements of common minerals and nutrients (cations and anions), total hardness, total alkalinity, total dissolved solids, and bacteria and pathogens. These parameters will form the basis of correlations between the biological characteristics and the physicochemical characteristics of the streams. Flow characteristics and other stream measurements taken by the USGS will also be used in correlating stream characteristics to stream fauna.

Inorganic anions and cations included in the analysis were calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), hydroxide (OH), carbonate (CO_3), bicarbonate (HCO_3), sulfate (SO_4), and chloride (Cl), reflecting total alkalinity, total hardness, and total dissolved solids. These inorganic anions and cations become a problem only when they are relatively concentrated, resulting in water that is high in total dissolved solids. Total dissolved solids for Piceance Creek, Stewart Creek, and Willow Creek range from 700-1050 ppm and are still within an acceptable range of tolerance (500-1500 ppm) set by the EPA for domestic water use if no other water source exists. The fluctuations in some common minerals over time probably reflect the environmental factors which control dissolution in water, such as temperature, rainfall, runoff, groundwater flows, and geologic formations over which the water flows.

Table II-66. MINERAL AND NUTRIENT CONTENT (mg/l) OF PICEANCE CREEK, STATIONS 1 THROUGH 7, TAKEN IN NOVEMBER AND DECEMBER 1974 AND JANUARY 1975

	Cations					Anions					
	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Ammonia (NH_4)	Hydroxide (OH)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)
Station P-1											
November	52	39	148	2.5	0.10	0	18	439	152	25	1.6
December	76	39	128	2.5	0.00	0	0	543	160	20	1.4
* January											
Station P-2											
November	60	51	144	2.2	0.09	0	12	464	229	20	3.3
December	80	62	132	2.3	0.00	0	12	543	246	20	5.9
January	88	61	138	2.3	0.13	0	24	525	277	25	4.3
Station P-3											
November	68	53	140	2.3	0.18	0	6	488	234	25	2.9
December	84	61	140	2.3	0.00	0	12	537	275	20	6.2
January	84	61	141	2.3	0.08	0	12	494	287	25	5.7
** **Station P-4**											
November	68	53	140	2.3	0.25	0	6	488	246	25	2.9
December											
January											
Station P-5											
November	66	56	136	2.5	0.05	0	18	494	244	20	2.9
December	64	61	-	-	0.00	0	48	415	275	20	5.9
January	64	63	141	2.5	0.00	0	30	415	305	25	6.3
Station P-5A											
November	48	57	140	2.5	0.07	0	18	415	257	20	2.9
December	72	63	140	2.5	0.00	0	0	561	249	20	5.4
January	74	64	147	2.5	0.00	0	12	506	308	30	4.6
Station P-6											
November	U.S.G.S.										
December											
January											
Station P-7											
November											
December	82	69	164	2.5	0.00	0	12	512	389	20	2.3
* January											

Table II-66 (Continued)

	Organics		Inorganics								
	Ortho Phosphate (PO_4)	Ammonia (N)	Boron (B)	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Nitrate (N)	Nitrate (N)	Total Alkalinity ($CaCO_3$)	Total Hardness ($CaCO_3$)	Oissolved Solids
Station P-1											
November	0.07	0.08	0.25	18	1.1	0.0	0.00	0.36	390	290	888
December	0.00	0.00	0.18	18	1.3	0.0	0.00	0.31	445	350	728
* January											
Station P-2											
November	0.00	0.07	0.17	18	0.4	0.0	0.04	0.74	400	360	928
Oecember	0.00	0.00	0.18	18	1.2	0.0	0.005	1.30	465	455	852
January	0.06	0.10	0.10	19	0.91	0.0	0.008	0.97	470	470	928
Station P-3											
November	0.04	0.15	0.17	18	1.60	0.0	0.008	0.66	410	390	952
Oecember	0.08	0.00	0.18	18	1.20	0.0	0.00	1.40	460	460	920
January	0.0S	0.06	0.20	19	1.10	0.0	0.00	1.30	425	460	936
** Station P-4											
November	0.17	0.19	0.17	18	1.40	0.0	0.005	0.65	410	390	968
Oecember											
January											
Station P-5											
November	0.02	0.04	0.17	19	1.70	0.0	0.008	0.66	435	395	984
December	0.00	0.00	0.18	18	-	0.0	-	1.30	420	410	810
January	0.04	0.00	0.20	21	1.40	0.0	0.020	1.40	390	420	940
Station P-5A											
November	0.21	0.0S	0.50	1S	0.70	0.0	0.04	0.66	370	355	936
Oecember	0.00	0.00	0.18	18	0.57	0.0	0.008	1.20	460	440	856
January	0.00	0.00	0.30	20	0.53	0.0	0.014	1.00	435	450	950
Station P-6											
November	U.S.G.S.										
Oecember											
January											
Station P-7											
November											
Oecember	0.00	0.00	0.27	20	3.00	0.0	0.00	0.51	440	490	1032
* January											

Table II-66 (Concluded)

	Dissolved Oxygen (ppm)	pH	Specific Cond. (μm)	Temp. (°C)
Station P-1				
November	14.9	8.1	1200	4.0
December	15.0	8.2	1280	0.0
* January				
Station P-2				
November	15.0	8.0	1350	4.5
December	15.0	8.2	1490	0.0
January	15.0	8.3	1000	0.0
Station P-3				
November	15.0	8.2	1380	4.0
December	15.0	8.2	1540	0.0
January	15.0	8.2	850	0.0
** Station P-4				
November	15.0	8.0	1480	4.0
December				
January				

	Dissolved Oxygen (ppm)	pH	Specific Cond. (μm)	Temp. (°C)
Station P-5				
November	15.0	8.5	1420	3.5
December	15.0	8.3	1470	0.0
January	15.0	8.3	690	0.0
Station P-5A				
November	15.0	8.0	1330	3.0
December	15.0	8.2	1500	0.0
January	15.0	8.3	600	0.0
Station P-6				
November	U.S.G.S.			
December				
January				
Station P-7				
November	15.0	8.3	-	0.0
December	15.0	8.3	1700	0.0
* January				

* Stations were frozen over.
** Station P-4 was eliminated in December 1974.

Table II-67. MINERAL AND NUTRIENT CONTENT (mg/1) OF STEWART CREEK, STATIONS 1 AND 2, AND UPPER AND LOWER STEWART LAKES, TAKEN IN NOVEMBER AND DECEMBER 1974 AND JANUARY 1975

	Cations					Anions					
	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Ammonia (NH_4)	Hydroxide (OH)	Carbonate (CO3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)
Station S-1											
November	U.S.G.S.										
December											
January											
Station S-2											
November	86	74	156	2.0	0.39	0.0	24	476	410	15	8.9
December	92	78	136	1.5	0.00	0.0	30	378	404	15	19.0
* January											
Station SL-1											
November											
December											
January											
Station SL-2											
November	94	61	128	1.7	0.00	0.0	18	415	376	15	13.0
December	58	69	136	1.5	0.00	0.0	36	427	239	20	19.0
January	84	85	132	1.7	0.00	0.0	18	439	409	20	16.0

	Organics		Inorganics								
	Ortho Phosphate (PO_4)	Ammonia (N)	Boron (B)	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Nitrate (N)	Nitrate (N)	Total Alkalinity ($CaCO_3$)	Total Hardness ($CaCO_3$)	Dissolved Solids
Station S-1											
November	U.S.G.S.										
December											
January											
Station S-2											
November	0.04	0.30	0.33	18.0	0.44	0.0	0.008	2.0	430	520	1076
December	0.16	0.00	0.09	17.0	0.33	0.0	0.009	4.3	370	550	992
*January											
Station SL-1											
November											
December											
January											
Station SL-2											
November	0.06	0.00	0.17	18.0	0.14	0.0	0.000	2.9	370	485	984
December	0.02	0.00	0.18	16.0	0.01	0.0	0.023	4.3	410	390	976
January	0.00	0.00	0.30	18.0	0.63	0.0	0.010	3.6	390	560	980

Table II-67. (Concluded)

	Dissolved Oxygen (ppm)	pH	Specific Cond. (μm)	Temp. (°C)
Station S-1				
November	U.S.G.S.			
December				
January				
Station S-2				
November	15.0 +	8.0	1750	3.0
December	15.0 +	8.4	1670	0.0
* January				
* Station SL-1				
November				
December				
January				
Station SL-2				
November	12.1	8.1	1500	7.5
December	9.0	7.8	1430	7.8
January	9.0	-	1700	8.0

* Stations were frozen over.

Table II-68. MINERAL AND NUTRIENT CONTENT (mg/1) OF WILLOW CREEK, STATIONS 1 THROUGH 3, AND UPPER AND LOWER WILLOW LAKES, TAKEN IN NOVEMBER AND DECEMBER 1974 AND JANUARY 1975

	Cations					Anions					
	Calcium (Ca)	Magnesium (Mg.)	Sodium (Na)	Potassium (K)	Ammonia (NH_4)	Hydroxide (OH)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)
Station W-1											
November	89	58	108	1.4	0.13	0.00	12.0	403	313	15	2.4
December	96	61	104	1.4	0.00	0.00	6.0	427	326	20	2.8
* January											
Station W-2											
November	88	68	128	1.7	0.14	0.00	18.0	439	334	20	1.5
December	110	62	120	1.4	0.00	0.00	12.0	488	339	20	1.5
* January											
Station W-3											
November	98	70	140	2.2	0.12	0.00	12.0	500	382	20	3.4
December	116	58	132	1.9	0.00	0.00	12.0	476	382	20	2.1
January	112	73	126	2.0	0.22	0.00	24.0	482	382	25	2.8
Station WL-1											
November	90	72	120	1.5	0.00	0.00	24.0	451	325	15	1.6
December	112	64	116	1.4	0.00	0.00	0.0	537	330	15	1.7
January	92	62	117	1.7	0.23	0.00	12.0	433	338	25	2.1
Station WL-2											
November	108	61	132	1.4	0.10	0.00	6.0	488	351	15	1.5
December	118	70	124	1.4	0.00	0.00	0.0	561	362	20	1.5
January	106	50	132	1.5	0.05	0.00	18.0	506	363	25	1.6

Table II-68 (Continued)

	Organics		Inorganics								
	Ortho Phosphate (PO_4)	Ammonia (N)	Boron (B)	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Nitrate (N)	Nitrate (N)	Total Alkalinity ($CaCO_3$)	Total Hardness ($CaCO_3$)	Dissolved Solids
Station W-1											
November	0.0	0.10	0.08	16.0	0.94	0.0	0.008	0.55	350	450	852
December	0.0	0.00	0.18	17.0	0.11	0.0	0.005	0.62	360	490	860
* January											
Station W-2											
November	0.0	0.11	0.02	19.0	0.72	0.0	0.000	0.33	390	500	940
December	0.04	0.00	0.18	17.0	0.54	0.0	0.010	0.34	420	530	932
* January											
Station W-3											
November	0.11	0.09	0.08	21.0	0.31	0.0	0.005	0.77	430	535	1032
December	0.16	0.00	0.18	19.0	2.7	0.0	0.000	0.48	410	530	964
January	0.02	0.17	0.20	19.0	1.6	0.0	0.010	0.64	435	580	1024
Station WL-1											
November	0.06	0.00	0.08	20.0	0.07	0.0	0.000	0.36	410	520	936
December	0.00	0.00	0.09	16.0	0.21	0.0	0.005	0.39	440	545	904
January	0.07	0.18	0.20	19.0	0.38	0.0	0.014	0.48	375	485	960
Station WL-2											
November	0.07	0.08	0.08	21.0	0.12	0.0	0.000	0.34	465	520	992
December	0.02	0.00	0.18	20.0	0.00	0.0	0.000	0.33	460	585	976
January	0.14	0.04	0.20	20.0	0.21	0.0	0.005	0.36	445	470	984

Table II-68 (Concluded)

	Dissolved Oxygen (ppm)	pH	Specific (Cond. (µm)	Temp. (°C)
Station W-1				
November	15.0 +	8.2	1380	-.5
December	15.0 +	8.2	1440	2.0
* January				
Station W-2				
November	15.0 +	8.2	1550	3.5
December	15.0 +	8.2	1590	3.5
* January				
Station W-3				
November	15.0 +	8.3	1700	6.0
December	15.0 +	8.2	1670	2.8
January	15.0 +	8.2	1730	2.0
Station WL-1				
November	15.0 +	8.2	1550	4.0
December	15.0 +	7.8	1600	2.8
January	15.0 +		1500	2.0
Station WL-2				
November	15.0 +	8.3	1600	7.0
December	15.0 +	7.5	1730	7.2
January	15.0 +		1700	5.0

* Stations were frozen over.

Table II-69. MINERAL AND NUTRIENT CONTENT (mg/1) OF THE WHITE RIVER, STATIONS 1 AND 2, TAKEN IN NOVEMBER AND DECEMBER 1974 AND JANUARY 1975

	Cations					Anions					
	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Ammonia (NH_4)	Hydroxide (OH)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)
Station WR-1											
November	68	19	34	1.4	0.00	0.0	12.0	146	135	40	0.18
December	74	21	35	1.2	0.00	0.0	0.0	171	135	45	1.10
January	72	23	57	1.7	0.10	0.0	12.0	195	153	43	1.30
Station WR-2											
November	72	28	57	1.5	0.00	0.0	12.0	229	150	40	0.93
December	74	28	57	1.5	0.00	0.0	0.0	238	157	45	1.20
January	72	22	39	1.7	0.00	0.0	6.0	165	140	4	1.20

	Organics		Inorganics								
	Ortho Phosphate (PO_4)	Ammonia (N)	Boron (B)	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Nitrate (N)	Nitrate (N)	Alkalinity ($CaCO_3$)	Hardness ($CaCO_3$)	Dissolved Solids
Station WR-1											
November	0.00	0.00	0.17	16	0.36	0.0	0.0	0.04	140	250	408
December	0.00	0.00	0.00	16	0.05	0.0	0.005	0.26	140	270	404
January	0.00	0.08	0.20	18	0.31	0.0	0.010	0.29	180	275	452
Station WR-2											
November	0.00	0.00	0.17	16	0.66	0.0	0.014	0.21	200	280	480
December	0.12	0.00	0.00	15	0.07	0.0	0.005	0.28	195	300	488
January	0.00	0.00	0.20	18	0.19	0.0	0.014	0.26	145	270	404

	Dissolved Oxygen (ppm)	pH	Specific Cond. (μm)	Temp. (°C)
Station WR-1				
November	15.0 +	8.0	660	-0.5
December	15.0 +	8.0	690	0.0
January	15.0 +	8.2	800	0.0
Station WR-2				
November	15.0 +	8.0	810	0.0
December	15.0 +	8.0	870	0.0
January	15.0 +	8.1	720	0.0

Table II-70. MICROBIOLOGY OF PICEANCE CREEK, STATIONS 1 THROUGH 7, TAKEN IN NOVEMBER AND DECEMBER 1974 AND JANUARY 1975

	Standard Plate Count/ml at 35° C.	Coliform MPN/100 ml	Fecal Coliform MPN/100 ml	Fecal Streptococci MPN/100 ml	Pathogens
Station P-1					
November	280,000	23	4	43	Not Detected
December	170,000	1,100	23	43	" "
* January					
Station P-2					
November	820,000	24,000	<3	23	
December	190,000	280	43	93	
January	20,000	1,100	23	7	
Station P-3					
November	270,000	750	<3	39	Not Detected
December	190,000	750	3	9	" "
January	35,000	460	460	240	" "
**Station P-4					
November	570,000	2,300	9	93	
December					
January					
Station P-5					
November	420,000	2,400	21	150	
December					
January	26,000	93	93	23	
Station P-6					
November					
December	550,000	93	43	4	
January	36,000	93	93	43	

Table II-70. (Concluded)

	Standard Plate Count/ml at 35°C.	Coliform MPN/100 ml	Fecal Coliform MPN/100 ml	Fecal Streptococci MPN/100 ml	Pathogens
Station P-6					
November	U.S.G.S.				
December					
January					
Station P-7					
November	590,000	<24,000	93	240	Not Detected
December	3,200,000	2,400	43	1,100	" "
* January					

* Stations were frozen over.

** Station P-4 was eliminated in December 1974.

Table II-71. MICROBIOLOGY OF STEWART CREEK, STATIONS 1 AND 2, AND UPPER AND LOWER STEWART LAKES, TAKEN IN NOVEMBER AND DECEMBER 1974 AND JANUARY 1975

	Standard Plate Count/ml at 35°C.	Coliform MPN/100 ml	Fecal Coliform MPN/100 ml	Fecal Streptococci MPN/100 ml	Pathogens
Station S-1					
November	U.S.G.S.				
December					
January					
Station S-2					
November	1,100,000	1,200	70	200	
December	910,000	4,600	<3	15	
* January					
Station SL-1					
* November					
* December					
* January					
Station SL-2					
November	550,000	1,100	<3	4	
December	230	9	<3	<3	
January	2,500	<3	<3	9	

* Stations were frozen over.

Table II-72. MICROBIOLOGY OF WILLOW CREEK, STATIONS 1 THROUGH 3, AND UPPER AND LOWER WILLOW LAKES, TAKEN IN NOVEMBER AND DECEMBER 1974 AND JANUARY 1975.

	Standard Plate Count/ml at 35°C.	Coliform MPN/100 ml	Fecal Coliform MPN/100 ml	Fecal Streptococci MPN/100 ml	Pathogens
Station W-1					
November	200,000	1,100	23	43	Not Detected
December	710,000	750	<3	21	" "
* January					
Station W-2					
November	320,000	<24,000	<3	240	
December	19,000	4,600	<3	23	
* January					
Station W-3					
November	360,000	2,400	93	43	
December	26,000	1,500	7	750	
January	130,000	750	9	240	
Station WL-1					
November	1,400,000	75	<3	9	
December	1,000,000	240	<3	93	
January	95,000	75	4	43	
Station WL-2					
November	39,000	<3	<3	<3	
December	110,000	9	<3	<3	
January	97,000	110	<3	15	

* Stations were frozen over.

Table II-73. MICROBIOLOGY OF THE WHITE RIVER, STATIONS 1 AND 2, TAKEN IN NOVEMBER AND DECEMBER 1974 AND JANUARY 1975

	Standard Plate Count/ml at 35°C.	Coliform MPN/100 ml	Fecal Coliform MPN/100 ml	Fecal Streptococci MPN/100 ml	Pathogens
Station WR-1					
November	54,000	1,500	240	9	Not Detected
December	6,600	1,500	390	93	" "
January	5,400	75	75	43	" "
Station WR-2					
November	52,000	240	2,100	23	
December	21,000	11,000	460	240	
January	4,000	1,100	93	43	

Analyses for common nutrients included ortho and total phosphate (PO_4), and nitrogen (nitrite, nitrate, and ammonia). These are indicators of organic pollutants whose source is animal waste and detritus, and are released through the natural biological process of decomposition.

The nitrogenous compounds ammonia (NH_4), nitrite (NO_2), and nitrate (NO_3) are set free in water by the decomposition of protein. Spring water and groundwater, which are usually not contaminated, contain only nitrate and no ammonia. Ammonia present in readily detectable quantities indicates continuing decomposition in the water because of incomplete oxidation of ammonia formed or introduced elsewhere.

Representative watercourses on Tract C-b all show relatively insignificant quantities of stable nitrate. In addition, the presence of little or no nitrate or ammonia indicates little contribution to the total nitrogen level through biological decomposition.

Trace element analysis included analyses for boron (B), silica (SiO_2), iron (Fe), and manganese (Mn). These elements were all well within acceptable tolerance ranges.

Coliform, as defined in Standard Methods for the Examination of Water and Wastewater, includes "all of the aerobic and facultative anaerobic, gram-negative, nonspore-forming, rod-shaped bacteria which ferment lactose with gas formation within 48 hours at $35^{o}C$."

The maximum acceptable coliform concentration in raw water used for drinking water supplies is 1000 per 100 milliliters for total coliforms and 2000 per 100 milliliters for fecal coliforms.

The presence of coliforms, and more specifically fecal coliforms and fecal streptococci, in water is indicative of fecal pollution. In general, the presence of fecal coliform and fecal streptococci organisms indicate more recent and possibly dangerous fecal contamination. When the count of fecal coliforms exceeds 2000 per 100 milliliters there is a high correlation

with increased numbers of both human pathogenic viruses and human pathogenic bacteria.

Although the fecal coliform test will not distinguish between wastes contributed by humans and those of nonhuman warm-blooded animals, such a separation is established through density relationships of fecal coliforms to fecal streptococci. In human fecal material, fecal coliform densities exceed those of fecal streptococci by a factor of 4 to 1. A complete reversal of this bacterial relationship is found in fecal contamination from livestock waste, with fecal streptococci being the more numerous of the two indicators, but the ratio is generally less than 0.7. The ratios of fecal streptococci to fecal coliforms along Piceance, Stewart, and Willow creeks were generally on the order of 1 to 10. On the White River, however, ratios of fecal coliforms to fecal streptococci ranged from 1.9 to 99. Generally, tests conducted on representative watercourses of Tract C-b indicate fecal contamination to be occurring from animal sources, due primarily to the cattle grazing on the meadows paralleling these watercourses.

Common and important pathogenic microorganisms tested for included *Salmonella*, *Shigella*, enteropathogenic *Escherichia coli*, *Leptospira*, and the enteric viruses. No pathogenic microorganisms were detected in Tract C-b watercourses.

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Terrestrial Vegetation Studies

III

TERRESTRIAL VEGETATION STUDIES

During this reporting period the primary efforts in vegetation studies have been concentrated on an update of the flora for Tract C-b. The initial list of vascular plant species contained limited information about the plants on the tract. In compliance with the requirements set forth in the program statement, additional information about each species has been incorporated into an annotated flora for the tract. In addition to family and scientific and common names, annotations include statement of abundance, community affinity or habitat type in which a species is most likely to be encountered, life form (*sensu* Raunkiaer, 1934), and geographical distributions. Each of these annotations is described more fully below.

RESULTS AND DISCUSSION

Scientific and Common Names

The scientific nomenclature used in the flora follows Harrington's Manual of the Plants of Colorado (1964). However, in order to compensate for changes that have been made in the years since its publication, a listing of currently accepted scientific names prepared by Weber (1972) has been used to update names. Most of the older names have been included, with cross references so that desired information for any species can be retrieved.

Common names are familiar and easy to remember, but they are also ambiguous: the same common name may pertain to several different species.

Generally accepted common names are given for each species listed here. In addition, a separate alphabetical listing of common names and associated scientific names (Table III-1) has been included to aid in retrieval of species information.

Life Form

The characteristic way in which a plant grows (life form) can be used to organize and classify the plants of a region. Raunkiaer (1934) developed a classification system which groups plants on the basis of the position of the perennating bud (the part that gives rise to new growth). It may be located at the tip of a branch on a tall tree or within the seed of an annual plant. Raunkiaer's system divides all plants into seven major life forms: phanerophytes, chamaephytes, hemicryptophytes, cryptophytes, therophytes, stem succulents, and epiphytes. The major types are then divided into numerous subtypes (Table III-2).

Attempts have been made to correlate life forms with regional climate. Relationships can be seen, but for the most part, they are rather general. Deserts tend to have high percentages of annuals (therophytes), and tropical forests are composed mostly of trees and large shrubs (phanerophytes).

Most of the plants on Tract C-b are hemicryptophytes (48.2 percent) and phanerophytes (18.5 percent); while therophytes comprise 15.1 percent of the flora. Comparison of the life form spectrum for Tract C-b with Raunkiaer's normal spectrum (a world average) (Table III-3) shows that hemicryptophytes are 1.8 times as prevalent, and phanerophytes are only 0.4 times as prevalent. While cryptophytes account for only 14.0 percent of the flora, they are 2.3 times as prevalent as in the normal spectrum, thus producing a flora which is characterized by hemicryptophytes and cryptophytes. The percentage of distribution of the flora (Table III-3) suggests a shrubland with a high percentage of herbaceous perennials.

Table III-1. ALPHABETICAL LISTING OF COMMON NAMES FOR THE FLORA OF TRACT C-b

Common Name	Scientific Name(s)
TREES, SHRUBS, AND VINES	
Antelope bitterbrush	Purshia tridentata
Big sagebrush	Artemisia tridentata
Blue clematis	Clematis columbiana
Box elder	Acer negundo
Chokecherry	Prunus virginiana var. melanocarpa
Currant	Ribes cereum
Douglas fir	Pseudotsuga menziesii
Four-winged saltbush	Atriplex canescens
Gambel oak	Quercus gambelii
Golden currant	Ribes aureum
Greasewood	Sarcobatus vermiculatus
Horsebrush	Tetradymia canescens
Mormon tea	Ephedra viridis
Mountain mahogany	Cercocarpus montanus
Narrow-leaf cottonwood	Populus angustifolia
Oregon grape	Mahonia repens
Pinyon pine	Pinus edulis
Prickly pear	Opuntia polyacantha
Rabbitbrush	Chrysothamnus viscidiflorus
Rock spirea	Holodiscus dumosus
Rocky mountain juniper	Juniperus scopulorum
Rubber rabbitbrush	Chrysothamnus nauseosus
Serviceberry	Amelanchier alnifolia
Shadscale	Atriplex confertifolia
Siberian elm	Ulmus pumila
Silver buffaloberry	Shepherdia argentea
Skunkbush	Rhus trilobata

Table III-1 (Continued)

Smooth currant	*Ribes inerme*
Snakeweed	*Gutierrezia sarothrae*
Snowberry	*Symphoricarpos orephilus*
Utah juniper	*Juniperus osteosperma*
Western virgin's-bower	*Clematis ligusticifolia*
Wild buckwheat	*Eriogonum lonchophyllum*
Wild hops	*Humulus lupulus* var. *neomexicanus*
Wild rose	*Rosa woodsii*
Willow	*Salix* sp.
Winter fat	*Ceratoides lanata*
HERBS	
Alfalfa	*Medicago sativa*
Alumroot	*Heuchera parvifolia*
Aster	*Aster* sp.
Balsam root	*Balsamorhiza sagittata*
Baltic rush	*Juncus arcticus* ssp. *ater*
Barnyard grass	*Echinochloa crus-galli* var. *mitis*
Bastard toadflax	*Comandra pallida* ssp. *umbellata*
Beard tongue	*Penstemon* sp.
Bee plant	*Cleome serrulata*
Biennial wormwood	*Artemisia biennis*
Blue-bunch wheatgrass	*Agropyron spicatum*
Blue grama	*Bouteloua gracilis*
Blue lettuce	*Lactuca tatarica* ssp. *pulchella*
Canada thistle	*Cirsium arvense*
Cattail	*Typha latifolia*
Cheatgrass	*Bromus tectorum*
Checker mallow	*Sidalcea neomexicana*
Cinquefoil	*Potentilla gracilis*
Clover	*Trifolium gymnocarpon*
Colorado bedstraw	*Galium coloradoensis*

Table III-1 (Continued)

Common reed	*Phragmites australis*
Common sunflower	*Helianthus annuus*
Crested wheatgrass	*Agropyron desertorum*
Curly-cup gumweed	*Grindelia squarrosa*
Dandelion	*Taraxacum officinale*
Darnel	*Lolium perenne*
Death camas	*Zigadenus venenosus* var. *gramineus*
Dock	*Rumex* sp.
Double bladderpod	*Phvsaria floribunda*
Easter daisy	*Townsendia hookeri*, *Townsendia incana*
Eriogonum	*Eriogonum flexum*
Evening primrose	*Calylophus hartwegii* ssp. *lavandulifelius*, *Oenothera trichocalyx*, *Oenothera* sp.
Evening star	*Mentzelia rusbyi*, *Mentzelia* sp.
Fairy candelabra	*Androsace septentrionalis*
False dandelion	*Agoseris glauca*
False flax	*Camelina microcarpa*
False gromwell	*Onosmodium molle* var. *occidentalis*
False Solomon's seal	*Smilacina stellata*
Fireweed	*Epilobium* sp.
Foxtail barley	*Hordeum jubatum*
Glaucous aster	*Aster glaucodes*
Goat's beard	*Tragopogon dubius*
Golden aster	*Heterotheca villosa*
Golden ragwort	*Senecio multilobatus*
Goldenrod	*Solidago sparsiflora*
Golden smoke	*Corydalis aurea*
Goldenweed	*Haplopappus nuttallii*
Goosefoot	*Chenopodium fremontii*, *Chenopodium* sp.
Great Basin wildrye	*Elymus cinereus*
Green sage	*Artemisia dracunculus* ssp. *glauca*
Gumbo lily	*Oenothera caespitosa*
Horsetail	*Equisetum arvense*

Horseweed	Conyza canadensis
Indian paintbrush	Castilleja chromosa, Castilleja linariaefolia
Indian ricegrass	Oryzopsis hymenoides
Japanese brome	Bromus japonicus
Junegrass	Koeleria gracilis
Kentrophyta milk vetch	Astragalus kentrophyta
Kentucky bluegrass	Poa pratensis
Larkspur	Delphinium nelsoni
Little ricegrass	Oryzopsis micrantha
Long-leaved phlox	Phlox longifolia
Lupine	Lupinus argenteus, Lupinus sp.
Malcolmia	Malcolmia africana
Mariposa lily	Calochortus gunnisoni, Calochortus nuttallii
Marsh elder	Iva xanthifolia
Meadow goldenrod	Solidago canadensis
Miner's candle	Cryptantha sp.
Moss phlox	Phlox hoodii
Mountain peppergrass	Lepidium montanum
Much-branched gayophytum	Gayophytum ramosissimum
Mutton grass	Poa fendleriana
Needle-and-thread grass	Stipa comata
Nodding brome	Bromus porteri
Nodding eriogonum	Eriogonum cernuum
Nuttall's sunflower	Helianthus nuttallii
Orchard grass	Dactylis glomerata
Pasque flower	Pulsatilla patens ssp. multifida
Pasture sage	Artemisia frigida
Peppergrass	Lepidium perfoliatum
Phacelia	Phacelia idahoensis
Pigweed	Amaranthus retroflexus
Prairie bulrush	Scirpus paludosus
Prickly lettuce	Lactuca serriola

Table III-1 (Continued)

Puccoon	*Lithospermum* sp.
Pussytoes	*Antennaria rosea*, *Antennaria parvifolia*
Rabbit's-foot grass	*Polypogon mouspelliensis*
Ragweed	*Ambrosia artemisiifolia*
Ragwort	*Senecio eremophilus* var. *kingii*
Red top	*Agrostis gigantea*
Rock cress	*Arabis holboellii*
Russian thistle	*Salsola iberica*
Sagewort	*Artemisia ludoviciana*
Sand dropseed	*Sporobolus cryptandrus*
Scarlet gilia	*Ipomopsis aggretata*
Scarlet globe mallow	*Sphaeralcea coccinea*
Scouring rush	*Equisetum hyemale*, *Equisetum laevigatum*
Seaside arrowgrass	*Triglochin maritima*
Sheep fescue	*Festuca brachyphylla*
Shore buttercup	*Ranunculus cymbalaria*
Short-rayed alkali aster	*Brachyactis frondosa*
Showy milkweed	*Asclepias speciosa*
Skeletonweed	*Lygodesmia grandiflora*
Slender wheatgrass	*Agropyron trachycaulum*
Sloughgrass	*Beckmannia syzigachne*
Smooth brome	*Bromus inermis*
Sow thistle	*Sonchus arvensis*
Speedwell	*Veronica salina*
Spreading dogbane	*Apocynum androsaemifolium*
Spurge	*Chamaesyce* sp., *Euphorbia robusta*
Squirreltail grass	*Sitanion longifolium*
Stickseed	*Lappula redowskii*
Stinging nettle	*Urtica dioica*
Sugarbowls	*Clematis hirsutissima*
Sulphur flower	*Eriogonum umbellatum*
Sweet vetch	*Hedysarum boreale*
Tansy mustard	*Descurainia pinnata*

Table III-1 (Concluded)

Tassel-flower brickellbrush	Brickellia grandiflora
Thistle	Cirsium sp.
Timothy	Phleum pratense
Tule	Scirpus lacustris ssp. validus
Tumble mustard	Sisymbrium altissimum
Twistflower	Streptanthus cordatus
Umbrellawort	Oxybaphus linearis
Utah daisy fleabane	Erigeron utahensis
Watercress	Rorippa nasturtium-aquaticum
Western wheatgrass	Agropyron smithii
White pigweed	Amaranthus albus
White sweet clover	Melilotus alba
Wild flax	Linum lewisii
Wild licorice	Glycyrrhiza lepidota
Winged eriogonum	Eriogonum alatum
Wing-fruited sand verbena	Tripterocalyx micranthus
Yarrow	Achillea lanulosa
Yellow evening primrose	Oenothera strigosa
Yellow sweet clover	Melilotus officinalis
Yucca	Yucca glauca

Table III-2. ABBREVIATIONS OF LIFE FORMS OF PLANTS USED IN DESCRIBING THE FLORA OF TRACT C-b

Ph - Phanerophytes (perennating bud at least 0.25 m above soil surface)

- MM - Mega-, Mesophanerophytes (>8 m in height)
- M - Microphanerophytes (2-8 m in height)
- N - Nanophanerophytes (0.25-2.0 m in height)
  (suffix "v" with any of the above symbols indicates a vine)

Ch - Chamaephytes (perennating bud between 0 and 0.25 m above soil surface)

- Chp - passive chamaephytes
- Chcp - cushion plants

H - Hemicryptophytes (perennating bud in soil surface)

- Hp - Proto-hemicryptophytes without runners (plant leafy throughout)
- Hs - Semirosette without runners (plant with large basal leaves and smaller cauline leaves)
- Hr - Rosette without runners (plant with well-developed basal leaves and no cauline leaves)
- Hpr - Proto-hemicryptophytes with runners
- Hsr - Semirosette with runners
- Hrr - Rosette with runners
  (runner is here used for either hypogeal or epigeal shoot)

Cr - Cryptophytes (perennating buds covered by soil or water)

- G - Geophytes (perennating buds covered by soil)
  - Grh - Rhizome
  - Gst - Stem-tuber
  - Grt - Root-tuber
  - Gb - Bulb
  - Gr - Root-bud
  - Gp - Root-parasite
- HH - Helo-, hydrophytes (perennating buds covered by water)

Th - Therophytes (annual plants, perennating buds contained in seed)

S - Stem succulents (stems enlarged; serve as water storage organ)

Table III-3. LIFE FORM SPECTRUM OF SPECIES[a] ON TRACT C-b

Life Form	Percentage Distribution of Species: Tract C-b	Normal Spectrum[b]
Phanerophytes	18.5	46.0
Chamaephytes	3.5	9.0
Hemicryptophytes	48.2	26.0
Cryptophytes	14.0	6.0
Therophytes	15.1	13.0

[a]172 species

[b]After Raunkiaer, 1934

Statement of Abundance

The qualitative statements of abundance are based on field observations and range along a continuous scale divided into six categories: rare, scattered, occasional, frequent, common, and abundant. In some instances these are qualified with the modifiers "very" and "relatively" to more accurately describe abundance. An abundant species is one which would be commonly encountered almost anywhere within the study area, whereas a very rare species might require several weeks of searching to locate and is usually known from only one site. The abundance statements are likely to be changed as additional field work is conducted. Species new to the flora will be located, and additional sightings of rare species are likely.

Community Affinity

The species which comprise the Tract C-b flora are not uniformly distributed throughout the study area. Some species are restricted to specialized environments, while others tolerate a broad range of environmental characteristics. The community affinity given for each species in the flora describes the habitat type where that species is most likely to be encountered. In most instances the communities which are mentioned correspond to described communities of the study area, but in some instances species are restricted to very specific sites within major communities. Mormon tea, for example, is found only on sandstone outcrops within pinyon-juniper woodlands (on Tract C-b). As more observations of species are made, some of the community affinity descriptions may be modified.

Distributional Status

Two levels of distribution are presented in the flora. The first simply states whether a species is either native or introduced within the study area; the second examines more closely the distribution of each species. Based on geographic distributions presented by Scoggan (1957) in his floral treatment of the plants of Manitoba, each of the species is assigned to one of 17 distribution types (Table III-4).

Table III-4. SUMMARY OF THE GEOGRAPHICAL DISTRIBUTION OF THE SPECIES PRESENT IN THE FLORA OF TRACT C-b

Geographical Distribution	Number of Species	Percent of Flora
Circumpolar Distributions		
Arctic circumpolar (Ca)	4	2.3
Arctic-subarctic circumpolar (Cas)	3	1.7
Subarctic circumpolar (Cs)	1	0.6
Subarctic-temperate circumpolar (Cst)	2	1.1
Temperate circumpolar (Ct)	2	1.1
Subtotal	12	6.8
American Distributions		
Arctic American (Aa)	1	0.6
Arctic-subarctic America (Asa)	2	1.1
Subarctic American (As)	14	8.1
Western (Asw)	5	2.9
Subarctic-temperate Amer. (Ast)	6	3.5
Western (Astw)	10	5.8
Temperate American (At)	7	4.0
Western (Atw)	90	52.0
Subtotal	135	78.0
Other Distributions		
European (Ep)	12	7.0
Eurasian (Er)	12	7.0
African (Af)	1	0.6
Tropical American (Ta)	1	0.6
Subtotal	26	15.2
Total	173	

The greatest portion of the flora (78.0 percent) is made up of species having characteristic North American distributions (Table III-4), and 52 percent have temperate American Western distributions. While not apparent from these data, the flora contains Western species from two major floristic regions: the Rocky Mountains and the Intermountain West. At elevations above Tract C-b, Rocky Mountain species are more abundant; and at elevations lower than the tract, Intermountain West species are more common. Approximately 16 percent of the species in the area are introduced; they are primarily European and Eurasian.

Family

The family for each species is given in order to allow individuals acquainted with plant families to obtain clearer insight into the flora, even though the genera may be unfamiliar.

How to Use the Flora

The flora contains no keys for identification of plants collected on the tract. Harrington (1964) would be the most useful reference for identifying plants from this region. To obtain information about an individual species if the scientific name is known, one can refer to the alphabetical listing of scientific names in the annotated flora (Table III-5) (trees, shrubs, and vines are listed separately from herbs). If only the common name is known, one must first locate the plant in the listing of common names (Table III-1) (which also lists herbs separately from trees, shrubs, and vines) and then use the scientific name to refer to the annotated flora.

In this first version of the flora some information for a species may be lacking because of incomplete data. As more field work is conducted, the appropriate information will be added to the flora, and revisions will be made as needed.

Table III-5. ANNOTATED VASCULAR FLORA FOR TRACT C-b

TREES, SHRUBS, AND VINES

Acer negundo L. Box Elder. (MM). Rare on Tract C-b; moist gulches along intermittent streams (Cottonwood Gulch). Not a rare species in Colorado. At - native. Aceraceae.

Amelanchier alnifolia Nutt. Serviceberry. (M). Common; a dominant species in mixed mountain shrub communities. Asw - native. Rosaceae.

Artemisia tridentata Nutt. Big Sagebrush. (M). Abundant; valley floors, ridges, and slopes over most of the tract. A secondary dominant in mixed mountain shrub communities and a dominant in sagebrush communities. Atw - native. Compositae.

Atriplex canescens (Pursh) Nutt. Four-winged Saltbush. (N). Scattered; dry colluvial slopes. On C-b usually found in Indian ricegrass communities. Atw - native. Chenopodiaceae.

Atriplex confertifolia (Torr. et Fremont) S. Wats. Shadscale. (N). Scattered; dry colluvial slopes and Indian ricegrass communities. Atw - native. Chenopodiaceae.

Ceratoides lanata (Pursh) J.T. Howell. Winter Fat. (N). Frequent; occurs as a secondary dominant with big sagebrush in valley sagebrush communities; uncommon elsewhere. Atw - native. Chenopodiaceae. (Syn. = Eurotia lanata [Pursh] Moquin).

Cercocarpus montanus Raf. Mountain Mahogany. (N). Common; a dominant species in mixed mountain shrub communities and a component of the shrub stratum in pinyon-juniper woodlands. Atw - native. Rosaceae.

Chrysothamnus nauseosus (Pall.) Britt. in Britt. et Brown. Rubber Rabbitbrush. (N). Common; a dominant species in heavily grazed valley communities; a secondary dominant on chained pinyon-juniper sites. Atw - native. Compositae.

Chrysothamnus viscidiflorus (Hook.) Nutt. Little Rabbitbrush. (N). Occasional; ridges and chained pinyon-juniper woodlands. Less common than rubber rabbitbrush. Atw - native. Compositae.

Clematis ligusticifolia Nutt. ex T. et G. Western Virgin's-Bower. (Nv). Scattered; mixed mountain shrub communities and moist gulches. Atw - native. Ranunculaceae.

Clematis columbiana (Nutt.) T. et G. Blue Clematis. (Nv). Rare; sheltered gulches and steep forested north-facing slopes. Usually found on sites occupied by douglas-fir. Atw - native. Ranunculaceae.

Ephedra viridis Coville. Mormon Tea. (M). Scattered; sandstone outcrops and cliff tops. Atw - native. Ephedraceae.

(?) Eriogonum lonchophyllum T. et G. Wild Buckwheat. (N or Ch). Frequent; dry colluvial slopes and Indian ricegrass communities. Atw - native. Polygonaceae.

Eurotia lanata (Pursh) Moquin. See Ceratoides lanata.

Gutierrezia sarothrae (Pursh) Britt. et Rusby. Snakeweed. (Ch). Frequent; ridgetops and in chained pinyon-juniper woodlands. Atw - native. Compositae.

Holodiscus dumosus (Nutt.) Heller. Rock Spirea. (N). Very scattered; heads of draws and gulches, also along sheltered cliff bases on colluvial deposits. Atw - native. Rosaceae.

Humulus lupulus L. var. neomexicanus A. Nels. et Cockerell. Wild Hops. (Grh). Scattered; along permanent water courses (Piceance Creek) and irrigation ditches. Cst - native. Moraceae.

Juniperus osteosperma (Torr.) Little. Utah Juniper. (MM). Abundant; codominant species with pinyon pine in pinyon-juniper woodlands. More common than Rocky Mountain Juniper. Atw - native. Cupressaceae.

Juniperus scopulorum Sarg. Rocky Mountain Juniper. (MM). Relatively common; occurs as a secondary dominant with pinyon pine and Utah Juniper in pinyon-juniper woodlands. Atw - native. Cupressaceae.

Mahonia repens (Lindl.) G. Don. Oregon Grape. (Ch). Frequent; pinyon-juniper woodlands and mixed mountain shrub communities. Astw - native. Berberidaceae.

Opuntia polyacantha Haw. Prickly Pear. (S). Common; throughout the tract in all communities. May reach greater density in overgrazed areas. Atw - native. Cactaceae.

Pinus edulis Engelm. Pinyon Pine. (MM). Abundant; dominant species in pinyon-juniper woodlands. Atw - native. Pinaceae.

Populus angustifolia James. Narrow-leaf Cottonwood. (MM). Rare; on Tract C-b restricted to Cottonwood Gulch. Not a rare species in Colorado, but rather one of the most widespread streamside cottonwood species. Atw - native. Salicaceae.

Prunus virginiana L. var. melanocarpa (A. Nels.) Sarg. Chokecherry. (M). Occasional; mixed mountain shrub communities and moist draws. Ast - native. Rosaceae.

Pseudotsuga menziesii (Mirbel) Franco. Douglas Fir. (MM). Scattered; restricted to narrow draws with sheltered north- and northeast-facing exposures. The largest tree species in the area. Astw - native. Pinaceae.

Purshia tridentata (Pursh) DC. Antelope Bitterbrush. (N). Common; mixed mountain shrub communities, shrub layer of pinyon-juniper woodlands, and chained pinyon-juniper woodlands. Atw - native. Rosaceae.

Quercus gambelii Nutt. Gambel Oak. (M). Frequent; mixed mountain shrub communities and heads of draws. Atw - native. Fagaceae.

Rhus trilobata Nutt. ex T. et G. Skunkbush. (N). Scattered; mixed mountain shrub communities. Atw - native. Anacardiaceae.

Ribes aureum Pursh. Golden Currant. (N). Scattered; along intermittent streams, draws, and gulches. Atw - native. Grossulariaceae.

Ribes cereum Dougl. Currant. (N). Scattered; along intermittent streams, draws, and gulches. Atw - native. Grossulariaceae.

Ribes inerme Rydb. Smooth Currant. (N). Scattered; along Piceance Creek and irrigation ditches. Astw - native. Grossulariaceae.

Rosa woodsii Lindl. Wild Rose. (N). Occasional; draws, gulches, and intermittent streams. Asw - native. Rosaceae.

Salix sp. Willow. Salicaceae.

Sarcobatus vermiculatus (Hook.) Torr. Greasewood. (M). Frequent; dense stands present on alluvial fans on the north side of Piceance Creek. Atw - native. Chenopodiaceae.

Shepherdia argentea (Pursh) Nutt. Silver Buffaloberry. (N). Rare; deep gulches along intermittent streams (Sorghum Gulch). Not a rare species in Colorado, but very restricted on C-b. Atw - native. Eleagnaceae.

Symphoricarpos orephilus A. Gray. Snowberry. (N). Common; mixed mountain shrub communities, and as an understory component in pinyon-juniper woodlands. Atw - native. Caprifoliaceae.

Tetradymia canescens DC. Horsebrush. (N). Scattered; ridgetop sagebrush communities and chained pinyon-juniper woodlands. More common at higher elevations. Atw - native. Compositae.

Ulmus pumila L. Siberian Elm. (N). Rare; an introduced species much planted for shade. Only one small plant has been noted; an escapee from cultivation. Er - introduced. Ulmaceae.

HERBS

Achillea lanulosa Nutt. Yarrow. (Hsr). As - native. Compositae.

Agoseris glauca (Pursh) Raf. False Dandelion. (Hr). Relatively common; conspicuous in spring in pinyon-juniper woodlands. Atw - native. Compositae.

Agropyron smithii Rydb. Western Wheatgrass. (Grh). Relatively common; sagebrush communities and chained pinyon-juniper woodlands. Atw - native. Gramineae.

Agropyron desertorum (Fisch.) Schult. Crested Wheatgrass. (Hs). Relatively common; chained pinyon-juniper woodlands and other disturbed sites. This species is commonly seeded for range improvement. Er - introduced. Gramineae.

Agropyron spicatum (Pursh) Scribn. et Smith. Bluebunch Wheatgrass. (Hs). Frequent; dry colluvial slopes, Indian ricegrass communities, and pinyon-juniper woodlands. Atw - native. Gramineae.

(?) Agropyron trachycaulum (Link) Malte. Slender Wheatgrass. (Hs). As - native. Gramineae.

Agrostis gigantea Roth. Red Top. (Hsr). Frequent; irrigated pastures, along irrigation ditches and streams. Cs - native. Gramineae.

Amaranthus albus L. White Pigweed. (Th). Common; roadsides and disturbed sites. Atw - native. Amaranthaceae.

Amaranthus retroflexus L. Pigweed. (Th). Occasional; disturbed sites in all communities. Ta - introduced. Amaranthaceae.

Ambrosia artemisiifolia L. Ragweed. (Th). Frequent; roadsides, along streams, and on disturbed sites. At - native. Compositae.

Androsace septentrionalis L. Fairy Candelabra. (Th or short-lived Hr). Frequent; open slopes, sagebrush communities. Blooms in early spring. Ca - native. Primulaceae.

Anemone patens L. See Pulsatilla patens ssp. multifida.

Antennaria parvifolia Nutt. Pussytoes. (Chp). Frequent; pinyon-juniper and chained pinyon-juniper woodlands. As - native. Compositae.

Antennaria rosea Greene. Pussytoes. (Chp). Frequent; pinyon-juniper and chained pinyon-juniper woodlands. As - native. Compositae.

Apocynum androsaemifolium L. Spreading Dogbane. (Hp). Scattered; along intermittent streams in gulches and draws. As - native. Apocynaceae.

(?) Arabis holboellii Hornem. Rock Cress. (Hs). Scattered; pinyon-juniper woodlands. Flowering in early May. As - native. Cruciferae.

Artemisia biennis Willd. Biennial Wormwood. (Hs). Occasional; sandy intermittent stream sides and dry channels. At - native. Compositae.

Table III-5 (Continued)

Artemisia dracunculus L. ssp. glauca (Pallas) Hall et Clements. Green Sage. (Hs). Frequent; dry colluvial slopes and Indian ricegrass communities. Atw - native. Compositae.

Artemisia frigida Willd. Pasture Sage. (Hp or Ch). Frequent; dry colluvial slopes and Indian ricegrass communities. Cas - native. Compositae.

Artemisia ludoviciana Nutt. Sagewort. (Ch). Frequent; dry colluvial slopes and Indian ricegrass communities. At - native. Compositae.

Asclepias speciosa Torr. Showy Milkweed. (Grh). Atw - native. Asclepiadaceae.

(?) Aster fendleri A. Gray. Aster. (Hp). Atw - native. Compositae.

Aster frondosus (Nutt.) T. et G. See Brachyactis frondosa.

(?) Aster glaucodes Blake. Glaucous Aster. (Hp). Atw - native. Compositae.

Astragalus kentrophyta A. Gray. Kentrophyta Milk Vetch. (Hp). Frequent; exposed soil on steep slopes, weathered sandstone and disturbed sites. Atw - native. Leguminosae.

Balsamorhiza sagitta (Pursh) Nutt. Balsam Root. (Hr). Frequent; pinyon-juniper woodlands. Astw - native. Compositae.

Beckmannia syzigachne (Steud.) Fernald. Sloughgrass. (Th). Scattered; along Piceance Creek and possibly other more permanent water sources. As - native. Gramineae.

Bouteloua gracilis (H.B.K.) Lag. Blue Grama. (Hsr). Relatively common; pinyon-juniper and chained pinyon-juniper woodlands. Atw - native. Gramineae.

(?) Brachyactis frondosa (Nutt.) A. Gray. Short-rayed Alkali Aster. (Th). Atw - native. Compositae. (Syn. = Aster frondosus).

Brickellia grandiflora (Hook.) Nutt. Tassel Flower Brickellbrush. (Hs). Scattered; heads of draws and on colluvial deposits in gulches. Atw - native. Compositae.

(?) Bromus porteri (Coult.) Nash. Nodding Brome. (Hs). Scattered; along stream courses in dry gulches. Atw - native. Gramineae. (Syn. = Bromus anomalus Rupr. ex Fourn).

Bromus inermis Leyss. Smooth Brome. (Hsr). Scattered; along streams and irrigation ditches. Er - introduced. Gramineae.

Bromus japonicus Thunb. Japanese Brome. (Th). Scattered; chained pinyon-juniper woodlands and disturbed sites. Er - introduced. Gramineae.

Bromus tectorum L. Cheatgrass. (Th). Common; occurs in all communities, but is more frequent in sagebrush and valley floor communities. Ep - introduced. Gramineae.

Calochortus gunnisoni S. Wats. Mariposa Lily. (Gb). Rare; chained pinyon-juniper woodlands and ridgetop sagebrush communities. Atw - native. Liliaceae.

Calochortus nuttallii Torr. Mariposa Lily. (Gb). Frequent; ridgetop sagebrush communities. More common than the previous species. Atw - native. Liliaceae.

Calylophus hartwegii (Benth.) Raven ssp. lavandulifolius (T. et G.) Towner et Raven. Evening Primrose. (Hp). Occasional; chained pinyon-juniper woodlands. Atw - native. Onagraceae. (Syn. = Oenothera lavandulaefolia).

Camelina microcarpa Andrz. False Flax. (Th). Scattered; valley pastures and disturbed sites. Ep - introduced. Cruciferae.

(?) Castilleja chromosa A. Nels. Indian Paintbrush. (Gp). Occasional; ridgetop sagebrush communities and chained pinyon-juniper woodlands. Atw - native. Scrophulariaceae.

Castilleja linariaefolia Benth. in DC. Indian Paintbrush. (Gp). Frequent; ridgetop sagebrush communities and chained pinyon-juniper woodlands. Atw - native. Scrophulariaceae.

Chamaesyce sp. Spurge. Euphorbiaceae.

Chenopodium fremontii S. Wats. Goosefoot. (Th). Occasional; chained pinyon-juniper woodlands and disturbed sites. Atw - native. Chenopodiaceae.

Chenopodium sp. Goosefoot. Chenopodiaceae.

Chrysopsis villosa (Pursh) Nutt. ex DC. See Heterotheca villosa.

Cirsium arvense (L.) Scop. Canada Thistle. (Gr). Er - introduced. Compositae.

Cirsium sp. Thistle. Compositae.

Clematis hirsutissima Pursh. Sugarbowls. (Hp). Rare; mixed mountain shrub communities on north-facing slopes. Not a rare species in Colorado, but known from only one location on C-b (Grid W66, N64). Atw - native. Ranunculaceae.

Cleome serrulata Pursh. Bee Plant. (Th). Common; roadsides, disturbed sites, and dry washes. Atw - native. Capparidaceae.

Comandra umbellata (L.) Nutt. ssp. pallida (A.DC.) Piehl. Bastard Toadflax. (Grh). Frequent; chained pinyon-juniper and ridgetop sagebrush communities. Ast - native. Santalaceae.

Conyza canadensis (L.) Cronquist. Horseweed. (Th). Scattered; disturbed sites, and roadsides. Ast - native. Compositae.

Corydalis aurea Willd. Golden Smoke. (Hp). Occasional; steep sandy slopes and dry washes. As - native. Fumariaceae.

Cryptantha sp. Miner's Candle. Boraginaceae.

Dactylis glomerata L. Orchard Grass. (Hs). Scattered; pastures and hay meadows. Er - introduced. Gramineae.

Delphinium nelsoni Greene. Larkspur. (Grt). Occasional; ridgetop sagebrush communities and chained pinyon-juniper woodlands. Astw - native. Ranunculaceae.

Descurainia pinnata (Walt.) Britt. Tansy Mustard. (Th). Common; disturbed sites in all communities. A highly variable species, with 7 ssp. present in Colorado. Ast - native. Cruciferae.

Echinochloa crus-galli (L.) Beauv. var. mitis (Pursh) Peterm. Barnyard Grass. (Th). Scattered; disturbed sites in pastures, meadows, roadsides, and along streams. Er - introduced. Gramineae.

Elymus cinereus Scribn. et Merr. Great Basin Wildrye. (Hsr). Frequent; valley sagebrush communities and heads of draws. At one time this species was more widespread, but conversion of floodplains to irrigated hay meadows has reduced its abundance. Atw - native. Gramineae.

Epilobium sp. Fireweed. Onagraceae.

Equisetum arvense L. Horsetail. (Grh - life forms are usually not given for cryptogams). Occasional; along Piceance Creek and irrigation ditches. Ca - native. Equisetaceae.

(?) Equisetum hyemale L. Scouring Rush. (Grh - life forms are usually not given for cryptogams). Scattered; along Piceance Creek. Ast - native. Equisetaceae.

Equisetum kansanum Schaffner. See Equisetum laevigatum.

Equisetum laevigatum A. Br. Scouring Rush. (Grh - life forms are usually not given for cryptogams). Occasional; along Piceance Creek and other relatively permanent water bodies. Atw - native. Equisetaceae. (Syn. = Equisetum kansanum).

Erigeron utahensis A. Gray. Utah Daisy Fleabane. (Hp). Occasional; chained pinyon-juniper woodlands and ridgetop sagebrush communities. Atw - native. Compositae.

Eriogonum alatum Torr. Winged Eriogonum. (Hr). Occasional; pinyon-juniper woodlands and exposed outcrops. Atw - native. Polygonaceae.

Eriogonum crenuum Nutt. Nodding Eriogonum. (Th). Occasional; pastures, roadsides, and other disturbed sites. Astw - native. Polygonaceae.

(?) Eriogonum flexum M.E. Jones. Eriogonum. Scattered; disturbed sites and steep slopes. Atw - native. Polygonaceae.

Eriogonum umbellatum Torr. Sulphur Flower. (Hr). Scattered; mixed mountain shrub, more abundant on north-facing slopes. Atw - native. Polygonaceae.

Euphorbia robusta (Engelm.) Small. Spurge. (Hp). Scattered; dry colluvial slopes and Indian ricegrass communities. Atw - native. Euphorbiaceae.

Festuca brachyphylla Schultes. Sheep Fescue. (Hs). Occasional; pinyon-juniper woodlands and chained pinyon-juniper woodlands. Er - introduced. Gramineae.

Galium coloradoensis W.F. Wright. Colorado Bedstraw. (Hp). Scattered; steep dry colluvial slopes and Indian ricegrass communities. Atw - native. Rubiaceae.

(?) Gayophytum ramosissimum T. et G. Much-branched Gayophytum. (Th). Scattered; along Piceance Creek and other relatively permanent water bodies. Atw - native. Onagraceae.

Gilia aggregata (Pursh) Spreng. See Ipomopsis aggregata.

Glycyrrhiza lepidota Pursh. Wild Licorice. (Hp). Frequent; along Piceance Creek and irrigation ditches. Atw - native. Leguminosae.

Haplopappus nuttallii T. et G. Goldenweed. (Hp). Occasional; pinyon-juniper and chained pinyon-juniper woodlands. Astw - native. Compositae.

Grindelia squarrosa (Pursh) Dunal. Curly-cup Gumweed. (Hp). Frequent; roadsides and other disturbed sites. Atw - native. Compositae.

Hedysarum boreale Nutt. Sweet Vetch. (Hp). Scattered; ridgetop sagebrush communities and chained pinyon-juniper woodlands. Asa - native. Leguminosae.

Helianthus annuus L. Common Sunflower. (Th). Frequent; roadsides and disturbed sites. Atw - native. Compositae.

Helianthus nuttallii T. et G. Nuttall's Sunflower. (Hp). Occasional; along Piceance Creek and irrigation ditches. Atw - native. Compositae.

Heterotheca villosa (Pursh) Shinners. Golden Aster. (Hp). Relatively common; present in most communities on C-b but is uncommon in valley sagebrush communities. Atw - native. Compositae. (Syn. = Chrysopsis villosa).

Heuchera parvifolia Nutt. ex T. et G. Alumroot. (Hr). Occasional; mixed mountain shrub communities and draws and gulches. Astw - native. Saxifragaceae.

Hordeum jubatum L. Foxtail Barley. (Hs). Occasional; valley sagebrush communities and moist meadows. Asa - native. Gramineae.

Ipomopsis aggregata (Pursh) V. Grant. Scarlet Gilia. (Hs). Relatively common; roadsides, dry washes, and pinyon-juniper woodlands. Atw - native. Polemoniaceae. (Syn. = Gilia aggregata).

Iva xanthifolia Nutt. Marsh Elder. (Th). Common; along Piceance Creek and irrigation ditches. Atw - native. Compositae.

Juncus arcticus Willd. ssp. ater (Rydb.) Hulten. Baltic Rush. (Grh). Scattered; marshes and along Piceance Creek and irrigation ditches. As - native. Juncaceae. (Syn. = Juncus balticus).

Juncus balticus Willd. See Juncus arcticus ssp. ater.

Koeleria cristata (L.) Pers. See Koeleria gracilis.

Koeleria gracilis Pers. Junegrass. (Hs). Relatively common; ridgetop sagebrush communities and chained pinyon-juniper woodlands. Ct - native. Gramineae. (Syn. = Koeleria cristata).

Lactuca pulchella (Pursh) DC. See Lactuca tatarica ssp. pulchella.

Lactuca serriola L. Prickly Lettuce. (Th). Occasional; roadsides and disturbed sites. Ep - introduced. Compositae. (Syn. = Lactuca scariola).

Lactuca tatarica (L.) C.A. May ssp. pulchella (Pursh) Stebbins. Blue Lettuce. (Hs). Scattered; mixed mountain shrub communities and rarely along roadsides. As - native. Compositae. (Syn. = Lactuca pulchella).

Lappula redowskii (Hornem.) Greene. Stickseed. (Th). Relatively common; pastures, valley sagebrush communities, and chained pinyon-juniper woodlands. Asw - native. Boraginaceae.

Lepidium montanum Nutt. Mountain Peppergrass. (Hs). Common; valley sagebrush communities, disturbed sites, and occasionally in mixed mountain shrub communities. Atw - native. Cruciferae.

Lepidium perfoliatum L. Peppergrass. (Th). Frequent; pastures and heavily grazed sites. Ep - introduced. Cruciferae.

Linum lewisii Pursh. Wild Flax. (Hp). Frequent; dry colluvial slopes and Indian ricegrass communities. Aa - native. Linaceae.

Lithospermum sp. Puccoon. Boraginaceae.

Lolium perenne L. Darnel. (Hs). Relatively rare; disturbed sites. A species introduced in the area; possibly mixed with other grass seed. Ep - introduced. Gramineae.

(?) Lupinus argenteus Pursh. Lupine. (Hp). Atw - native. Leguminosae.

Lupinus sp. Lupine. Leguminosae.

Lygodesmia grandiflora (Nutt.) T. et G. Skeletonweed. (Gr). Scattered; dry slopes and pinyon-juniper woodlands. Atw - native. Compositae.

Malcolmia africana (L.) R. Br. Malcolmia. (Th). Common; roadsides and disturbed sites, especially around farm buildings. Blooms in very early spring. Af - introduced. Cruciferae.

Medicago sativa L. Alfalfa. (Hp). Abundant; this species is planted as a hay crop in the meadows along Piceance Creek, Willow Creek, and Stewart Creek. Er - introduced. Leguminosae.

Melilotus alba Desr. White Sweet Clover. (Hs). Frequent; along streams and dry washes. Occasionally along roadsides. Ep - introduced. Leguminosae.

Melilotus officinalis (L.) Lam. Yellow Sweet Clover. (Hs). Frequent; along streams and dry washes, occasionally along roadsides. Ep - introduced. Leguminosae.

Mentzelia rusbyi Wooton. Evening Star. (Grt). Occasional; dry colluvial slopes and roadsides. Atw - native. Loasaceae. (Syn. = Mentzelia nuda var. rusbyi).

<u>Mentzelia</u> sp. Evening Star. Loasaceae.

<u>Mirabilis linearis</u> (Pursh) Heimerl. See <u>Oxybaphus linearis</u>.

<u>Nasturtium officinale</u> R. Br. See <u>Rorippa pasturtium-aquaticum</u>.

<u>Oenothera caespitosa</u> Nutt. ex Fraser. Gumbo Lily. (Hr). Occasional; steep roadsides and disturbed sites. Atw - native. Onagraceae.

<u>Oenothera lavandulaefolia</u> T. et G. See <u>Calylophus hartwegii</u> ssp. <u>lavandulifolius</u>.

<u>Oenothera</u> sp. Evening Primrose. Onagraceae.

<u>Oenothera strigosa</u> (Rydb.) Mack et Bush. Yellow Evening Primrose. (Hs). Scattered; along Piceance Creek and other moist areas. At - native. Onagraceae.

<u>Oenothera trichocalyx</u> Nutt. ex T. et G. Evening Primrose. (Hs). Rare; dry washes and alluvial deposits. Atw - native. Onagraceae.

<u>Onosmodium molle</u> Michx. var. <u>occidentalis</u> (Mack.) Johnston. False Gromwell. (Hs). Scattered; roadsides and dry slopes. At - native. Boraginaceae.

<u>Oryzopsis hymenoides</u> (R. et S.) Ricker. Indian Ricegrass. (Hs). Common; dry colluvial slopes and chained pinyon-juniper woodlands. Atw - native. Gramineae.

<u>Oryzopsis micrantha</u> (Trin. et Rupr.) Thurber. Little Ricegrass. (Hs). Scattered; pinyon-juniper woodlands and valley sagebrush communities. Atw - native. Gramineae.

<u>Oxybaphus linearis</u> (Pursh) Robbins. Umbrellawort. (Hp). Scattered; sandy ridges and slopes. Atw - native. Nyctaginaceae. (Syn. = <u>Mirabilis linearis</u>).

<u>Penstemon</u> sp. Beard Tongue. Scrophularicaeae.

(?) <u>Phacelia idahoensis</u> Henderson. Phacelia. (Hp). Occasional; pinyon-juniper woodlands and roadsides. Atw - native. Hydrophyllaceae.

Phleum pratense L. Timothy. (Hs). Frequent; hay meadows and pastures. Er - introduced. Gramineae.

(?) Phlox hoodii Rich. Moss Phlox. (Chcp). Common; pinyon-juniper woodlands, ridgetop sagebrush communities, and chained pinyon-juniper woodlands. Asw - native. Polemoniaceae.

Phlox longifolia Nutt. Long-leaved Phlox. (Hp). Frequent; ridgetop sagebrush communities and chained pinyon-juniper woodlands. Atw - native. Polemoniaceae.

Phragmites australis (Cav.) Trin. ex Steud. Common Reed. (Hsr). Common; marshes and along Piceance Creek. Restricted to wet environments. Cst - native. Gramineae. (Syn. = Phragmites communis).

Phragmites communis Trin. See Phragmites australis.

Physaria floribunda Rydb. Double Bladderpod. (Hr). Frequent; steep slopes, dry washes, and pinyon-juniper woodlands. Atw - native. Cruciferae.

Poa fendleriana (Steud.) Vasey. Muttongrass. (Hs). Scattered; ridgetop sagebrush communities and chained pinyon-juniper woodlands. Atw - native. Gramineae.

Poa pratensis L. Kentucky Bluegrass. (Grh). Frequent; meadows, pastures, and along streams and irrigation ditches. Cas - introduced. Gramineae.

Polypogon monspeliensis (L.) Desf. Rabbit's-foot Grass. (Th). Scattered; along streams and irrigation ditches. Ep - introduced. Gramineae.

(?) Potentilla gracilis Dougl. ex Hook. Cinquefoil. (Hs). Relatively rare; sheltered gulches along rocky intermittent streams. Asw - native. Rosaceae.

Pulsatilla patens (L.) Mill. ssp. multifida (Pritzel) Zamels. Pasque Flower. (Hs). Rare; north-facing mountain shrub communities. Not rare in Colorado, but very restricted on Tract C-b. Ranunculaceae.

Ranunculus cymbalaria Pursh. Shore Buttercup. (Hsr). Scattered; wet sandy and streamside deposits along Piceance Creek. Ca - native. Ranunculaceae.

Rorippa nasturtium-aquaticum (L.) Schinz et Thell. Watercress. (HH). Scattered; in streams and shallow water, Stewart Creek. Ep - introduced. Cruciferae. (Syn. = Nasturtium officinale).

Rumex sp. Dock. Polygonaceae.

Salsola iberica Sennen et Pau. Russian Thistle. (Th). Common; roadsides and disturbed sites. Er - introduced. Chenopodiaceae. (Syn. = Salsola kali var. tenuiflora).

Salsola kali L. var. tenuiflora Tausch. See Salsola iberica.

Scirpus lacustris L. ssp. validus (Vahl) Koyama. Tule. (Grh). Scattered; along Piceance Creek and other relatively permanent streams. As - native. Cyperaceae. (Syn. = Scirpus validus).

Scirpus paludosus A. Nels. Prairie Bulrush. (Grh). Scattered; along Piceance Creek and other relatively permanent streams. Astw - native. Cyperaceae.

Scirpus validus Vahl. See Scirpus lacustris ssp. validus.

Senecio eremophilus Rydb. var. kingii (Rydb.) Greenm. Ragwort. (Hp). Occasional; chained pinyon-juniper woodlands. Atw - native. Compositae.

Senecio multilobatus T. et G. ex A. Gray. Golden Ragwort. (Grh). Occasional; pinyon-juniper and chained pinyon-juniper woodlands. Atw - native. Compositae.

Sidalcea neomexicana A. Gray. Checker Mallow. (Hp). Occasional; hay meadows and pastures along Piceance Creek. Atw - native. Malvaceae.

Sisymbrium altissimum L. Tumble Mustard. (Th). Relatively common; chained pinyon-juniper woodlands and disturbed sites. Ep - introduced. Cruciferae.

Sitanion hystrix (Nutt.) J.G. Smith. See Sitanion longifolium.

Sitanion longifolium J.G. Smith. Squirreltail Grass. (Hs). Frequent; sagebrush communities and chained pinyon-juniper woodlands. Atw - native. Gramineae. (Syn. = Sitanion hystrix).

Smilacina stellata (L.) Desf. False Solomon's Seal. (Grh). Relatively rare; Douglas-fir forests. As - native. Liliaceae.

Solidago canadensis L. Meadow Goldenrod. (Hsr). Scattered; along Piceance Creek. Ast - native. Compositae.

(?) Solidago sparsiflora A. Gray. Goldenrod. (Hsr). Scattered; along intermittent streams in draws and gulches. Atw - native. Compositae.

(?) Sonchus arvensis L. Sow Thistle. (Hsr). Scattered; meadows and pastures along Piceance Creek. Ep - introduced. Compositae.

Sphaeralcea coccinea (Pursh) Rydb. Scarlet Globe Mallow. (Hp). Common; ridgetop sagebrush communities and chained pinyon-juniper woodlands. Atw - native. Malvaceae.

(?) Sporobolus cryptandrus (Torr.) A. Gray. Sand Dropseed. (Hsr). Scattered; roadsides and sandy alluvial deposits. At - native. Gramineae.

Stipa comata Trin. et Rupr. Needle-and-Thread Grass. (Hs). Frequent; sagebrush communities and chained pinyon-juniper woodlands. Astw - native. Gramineae.

Streptanthus cordatus Nutt. ex T. et G. Twistflower. (Hs). Scattered; pinyon-juniper woodlands and chained pinyon-juniper woodlands. Atw - native. Cruciferae.

Taraxacum officinale Web. in Wiggers. Dandelion. (Hr). Frequent; roadsides and disturbed sites. Er - introduced. Compositae.

(?) Townsendia hookeri Beaman. Easter Daisy. (Hr). Frequent; ridgetop sagebrush communities, pinyon-juniper and chained pinyon-juniper woodlands. Atw - native. Compositae.

Townsendia incana Nutt. Easter Daisy. (Hr). Scattered; ridgetop sagebrush communities and chained pinyon-juniper woodlands. Atw - native. Compositae.

Table III-5 (Concluded)

Tragopogon dubius Scop. Goat's Beard. (Hs). Occasional; ridgetop sagebrush communities and chained pinyon-juniper woodlands. Ep - introduced. Compositae.

Trifolium gymnocarpon Nutt. Clover. (Hs). Relatively rare; pinyon-juniper woodlands and mixed mountain shrub communities. Atw - native. Leguminosae.

Triglochin maritima L. Seaside Arrowgrass. (Hr). Relatively rare; marshes and moist meadows along Piceance Creek and other streams. Cas - native. Juncaginaceae.

Tripterocalyx micranthus (Torr.) Hook. Wing-fruited Sand Verbena. (Th). Rare; sandy alluvial deposits. Atw - native. Nyctaginaceae.

Typha latifolia L. Cattail. (HH). Frequent; marshes and streamsides. Restricted to wet environments. As - native. Typhaceae.

Urtica dioica L. Stinging Nettle. (Hpr). Scattered; moist meadows in draws and gulches. As - native. Urticaceae.

Veronica salina Schur. Speedwell. (Hp). Scattered; streamside sites along Piceance Creek. Ct - native. Scrophulariaceae.

Yucca glauca Nutt. Yucca. (Hr). Occasional; chained pinyon-juniper woodlands. Atw - native. Liliaceae.

Zigadenus venenosus S. Wats. var. gramineus (Rydb.) Walsh ex M.E. Peck. Death Camas. (Gb). Scattered; ridgetop sagebrush communities and chained pinyon-juniper woodlands. Atw - native. Liliaceae.

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IN THE CONTRACTOR'S MANUSCRIPT

Dendrochronology and Dendroclimatology

IV

DENDROCHRONOLOGY AND DENDROCLIMATOLOGY

During this quarter all trees have been dated by the cross-dating method. Stand chronologies and a master chronology have been constructed. Dated growth increments from the master chronology were measured and a mean width of each annual increment was calculated for each tree.

Mean tree-ring measurements for each tree were converted to standardized indices and then correlated to October through June precipitation values using Spearman's rank correlation method. Those trees that were positively correlated to precipitation were used to make a dendroclimatic analysis. This analysis, which will give an indication of major climatic trends, will be included in the next quarterly report.

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IN THE CONTRACTOR'S MANUSCRIPT

Soil Survey and Productivity Assessment

SOIL PRODUCTIVITY PROGRAM

A soil productivity program was undertaken in January 1975 to meet the requirement for a bioassay of the productivity of soils on Tract C-b. A preliminary soil reconnaissance was conducted in early November, and seven areas were selected as tentatively representing at least seven different types of topsoil present on the tract.

Soil samples were collected in January and transported to California under a Colorado Agriculture Department certification indicating the soil was free of Colorado potato beetle infestation.

Subsamples of each soil type were screened through 1/4-inch-mesh hardware cloth and placed in three 14 x 14-inch flats to a depth of approximately 2 1/4 inches. Three control flats of vermiculite were also prepared. All 24 flats were planted with oats (*Avena sativa* var. victory) and barley (*Hordeum vulgare* var. briggs).

On January 30, fifty seeds of each species were planted 3/8 inch deep in each flat. One half of each flat contained oats and the other half contained barley. Deionized water was used for irrigating flats of the experimental soils, and a 50 percent Hoagland's solution was used for the controls at alternate watering periods. The plants were watered every two or three days, depending on weather and visual assessment of soil moisture. Following germination, 15 individuals of each species in

each flat were randomly selected for growth measurements. If an individual selected was less than 1/2 inch tall it was considered to be a genetic dwarf and another individual was selected using the random numbers table.

Initial growth measurements were made 13 days after planting. Measurements taken included total height of plant from soil surface, number of leaves, number of nodes, length of leaves, height to nodes, and length of internodes. These growth measurements were made at weekly intervals. Final growth measurements will be taken the week of March 2, 1975. Following the final growth measurements the plants will be harvested. The marked plants used for growth measurements will be individually weighed to obtain shoot and total biomass; root biomass will be determined for an average plant. All remaining plants of each species will be harvested and weighed to obtain root, shoot, and total biomass produced by each soil type and by the control flats.

The data accumulated will be statistically analyzed to ascertain differences between the productivity of the various soils as well as between the soils and the control.

It is anticipated that a final report on this program will be available for inclusion in the next quarterly report.

As mentioned in the First Quarterly Report, field work to determine the physical and chemical characteristics of the soils has been deferred until spring 1975 because the ground was frozen or covered with snow in the winter quarter.

ARCHAEOLOGICAL STUDIES

FISH AND WILDLIFE MANAGEMENT PLAN

III A FISH AND WILDLIFE MANAGEMENT PLAN

The Fish and Wildlife Management Plan for Tract C-b will be better defined as more information from the Terrestrial Wildlife and Aquatic Studies becomes available. The intensive big game studies which have been taking place during the winter months are expected to be valuable in formulating this Plan. It is important, however, to discuss early in the program the objectives, theories, and philosophies to be incorporated in such a plan, and these discussions have occupied much of this quarter.

During the Second Quarter, meetings were held with state and federal game and fish department officials with recent discussions focusing on the development of a Cooperative Piceance Basin Wildlife Plan, or at least a process for its achievement through proper government agencies. The C-b Shale Oil Project also recognizes the need for in-house coordination between the development engineers and the environmental staff to ensure that the Tract C-b Plan will address the tract-specific impacts that can be expected, and to formulate measures to minimize these impacts. To this end, a dialogue has been initiated among the contractors, operators, environmental staff, engineering staff, and management officers to alert all groups to the lease provisions and to the current status in the development of the Fish and Wildlife Managment Plan.

REVEGETATION PROGRAM

III B REVEGETATION PROGRAM

During the second quarter, revegetation planning had continued. It is the intent of the C-b Shale Oil Project to rehabilitate lands disturbed by the development of shale oil resources on Tract C-b in a manner consistent with good ecological practices, economic feasibility, and practical land use consideration.

A revegetation program will be developed to:

a) stabilize and control erosion on distrubed surfaces

b) support animal populations at least as extensive as those presently on Tract C-b

c) coordinate the natural processes of ecosystem recovery which occur indepENDnent of man with the best available management practices.

Two types of revegetation are important on Tract C-b: (a) the establishment of plant cover on sites disturbed during the exploratory and development phases of the project, and (b) revegetation of spent shale after the mining and retorting operation begins. The first is an immediate need; whereas, the second is a long-term project.

During the second quarter, disturbed areas have been identified for revegetation during the growing season of 1975. Planting procedures will be proposed.

Major site types requiring revegetation of disturbed soils include abandoned drill pads, access roads, and other cleared support sites. The revegetation of these sites followes more conventional techniques than for processed shale disposal sites. These conventional techniques will be evaluted in order to determine their suitability in establishing vegetation for support of wildlife, livestock and other existing animal populations.

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MICROENVIRONMENTAL PROGRAM

III C MICROENVIRONMENTAL PROGRAM

The four continuous recording microenvironmental stations were installed in late February. Stations are located in each of the four major vegetation types on Tract C-b (Pinyon-Juniper Woodland, chained Pinyon-Juniper Woodland, Valley Bottom Sagebrush, and Plateau Sagebrush). Continuous recordings were begun upon installation. Due to a lag period for instrument and sensor acclimatization, no data are available from the stations at this time. Data should be available for reporting at the end of the next quarter.

In addition to the recording microenvironmental stations, 17 relocatable spot check stations have been established to gather more limited micro-environmental data in a greater range of environments (see Quarterly Report #1 for details on the types of data gathered for the spot check stations and the recording stations). The spot check stations were established in the last quarter. No data have been interpreted from these sites. Tables III C-1 and II C-2 show the raw data for snow depth, density, and distribution, and for soil moisture, respectively.

Additional data for the spot check stations and data for the recording stations will be available for the next quarter. Interpretations will not be extensively made until a greater range of data is available.

TABLE III C-1

SOIL MOISTURE SURVEY

SITE DESCRIPTION	SAMPLE NO.	DEPTH OF SAMPLE	% MOISTURE
Chained Pinyon-Juniper 1VF	1	10"	will be included [illegible]
1VO	1	10"	
2VF	1	10"	
2VF	2	5"	
Sagebrush 3VF	1	30"	
3VF	2	18"	
3VO	1	29"	
3VO	2	17"	
3VO	3	6"	
4VF	1	28"	
4VF	2	16"	
4VO	1	31"	
4VO	2	19"	
Pinyon-Juniper 5VF	1	10"	
5VO	1	10"	
6VF	1	30"	
6VF	2	18"	
6VO	1	29"	
6VO	2	17"	

TABLE III C-1

SOIL MOISTURE SURVEY Cont.

SITE DESCRIPTION	SAMPLE NO.	DEPTH OF SAMPLE	% MOISTURE
Locals - Mouth of Sorghum 9	1	27"	
9	2	15"	
Mouth of W. Stewart 10	1	26"	
10	2	14"	
Bunchgrass 11	1	6 3/4"	
W. Stewart Valley Sage 12	1	27"	
12	2	15"	
N. facing slope 13	1	8"	
W. facing P.J. 14	1	28"	
14	2	18"	
Cottonwood Gulch 15	1	22"	
15	2	10"	
Scandard Lepidium 17	1	27"	
17	2	15"	

TABLE III C-2a

SNOW SURVEY
DECEMBER

SITE DESCRIPTION	SAMPLE NO.	DEPTH OF SNOW (cm)	WATER CONTENT (cm)	DENSITY %
Chained Pinyon-Juniper 1VF	1	11	2	18
1VF	2	13	2	15
1VF	3	10	4	40
1VF	4	9	2	22
1VO	1	9	0.5	6
1VO	2	10	2	20
1VO	3	10	1	10
1VO	4	8	3	38
2VF	1	8	2	25
2VF	2	14	4	14
2VF	3	14	1	7
2VF	4	14	2	14
2VO	1	10	2	20
2VO	2	8	1	12
2VO	3	10	2	20
2VO	4	10	1	10
Upland Sagebrush 3VF	1	20	1	5
3VF	2	17	4	24
3VF	3	17	2	12
3VF	4	18	3	17

TABLE III C-2a

SNOW SURVEY Cont.
DECEMBER

SITE DESCRIPTION	SAMPLE NO.	DEPTH OF SNOW (cm)	WATER CONTENT (cm)	DENSITY %
Upland Sagebrush Cont. 3VO	1	13	5	38
3VO	2	15	3	20
3VO	3	18	2	11
3VO	4	15	1	6
Valley Sagebrush 4VF	1	6	0.5	8
4VF	2	8	1	13
4VF	3	14	2	14
4VF	4	10	2	20
4VO	1	6	1	17
4VO	2	6	1	17
4VO	3	14	1	7
4VO	4	8	1	13
Pinyon-Juniper 5VF	1	14	1	7
5VF	2	17	2	12
5VF	3	13	1	8
5VF	4	14	2	14
5VO	1	8	0.5	6
5VO	2	22	3	14
5VO	3	3	0.5	17
5VO	4	18	4	22

TABLE III C-2a

SNOW SURVEY Cont.
DECEMBER

SITE DESCRIPTION	SAMPLE NO.	DEPTH OF SNOW (cm)	WATER CONTENT (cm)	DENSITY %
6 Veg. Plot				
6VF	1	10	1	10
6VF	2	6	1	17
6VF	3	8	1	13
6VF	4	14	3	21
6VO	1	22	2	9
6VO	2	8	1	13
6VO	3	8	2	25
6VO	4	18	2	11
South-facing slope				
ME8	1	0 Melted		
ME8	2	0 Melted		
ME8	3	0 Melted		
ME8	4	0 Melted		
ME9	1	12	2	17
ME9	2	10	1	10
ME9	3	8	2	25
ME9	4	10	2	20
North-facing slope				
ME13	1	26	4	15
ME13	2	26	3	12
ME13	3	28	4	14
ME13	4	26	3	12

TABLE III C-2a

SNOW SURVEY Cont.
DECEMBER

SITE DESCRIPTION	SAMPLE NO.	DEPTH OF SNOW (cm)	WATER CONTENT (cm)	DENSITY %
West-facing slope Pinyon-Juniper				
ME14	1	19	1	5
ME14	2	17	3	18
ME14	3	7	1	14
ME14	4	26	3	12
Bottom of Cotton-wood Gulch				
ME15	1	15	3	20
ME15	2	11	2	18
ME15	3	13	1	8
ME15	4	10	1	10
ME15	5	20	6	30
ME15	6	5	1	20
ME15	7	13	1	8
ME15	8	10	1	10
ME15	9	10	2	20
ME15	10	6	2	33
Head of Sorghum				
ME16	1	17	3	18
ME16	2	22	3	14
ME16	3	26	3	12
ME16	4	22	3	14

TABLE III C-2a

SNOW SURVEY Cont.
DECEMBER

SITE DESCRIPTION	SAMPLE NO.	DEPTH OF SNOW (cm)	WATER CONTENT (cm)	DENSITY %
Scandard Gulch Lepidium stand				
ME17	1	18	4	22
ME17	2	16	3	19
ME17	3	8	0.5	6
ME17	4	10	1	10
ME17	5	16	2	13
ME17	6	14	2	14
ME17	7	16	2	13
ME17	8	14	2	14
ME17	9	12	2	17
ME17	10	8	2	25

TABLE III C-2b

SNOW SURVEY
JANUARY

SITE DESCRIPTION	SAMPLE NO.	DEPTH OF SNOW (cm)	WATER CONTENT (cm)	DENSITY %
Chained Pinyon-Juniper 1VO	1	20	2	10
1VO	2	14	2	14
1VO	3	13	2	15
1VO	4	22	4	18
1VO	5	16	4	25
1VF	1	30	3	10
1VF	2	24	6	25
1VF	3	18	5	28
1VF	4	16	9	56
1VF	5	34	4	12
Control Chained Pinyon-Juniper 2VO	1	20	4	20
2VO	2	16	3	19
2VO	3	18	3	17
2VO	4	20	3	15
2VO	5	22	3	14
2VF	1	28	5	18
2VF	2	30	5	17
2VF	3	26	5	19
2VF	4	26	5	19
2VF	5	32	6	19

TABLE III C-2b

SNOW SURVEY Cont.
JANUARY

SITE DESCRIPTION	SAMPLE NO.	DEPTH OF SNOW (cm)	WATER CONTENT (cm)	DENSITY %
Plateau Sagebrush 3VO	1	20	4	20
3VO	2	16	2	13
3VO	3	20	3	15
3VO	4	16	3	19
3VO	5	19	5	26
3VF	1	19½	2	10
3VF	2	21	2	10
3VF	3	18	4	22
3VF	4	22	5	23
3VF	5	17	5	29
Valley Bottom Sagebrush 4VO	1	20	4	20
4VO	2	16	2	13
4VO	3	22	2	9
4VO	4	20	2	10
4VO	5	16	1	6
4VF	1	16	2	13
4VF	2	16	2	13
4VF	3	25	2	8
4VF	4	14	1	7
4VF	5	10	3	30

TABLE III C-2b

SNOW SURVEY Cont.
JANUARY

SITE DESCRIPTION	SAMPLE NO.	DEPTH OF SNOW (cm)	WATER CONTENT (cm)	DENSITY %
Pinyon-Juniper near Sorghum Gulch 5VO	1	18	4	22
5VO	2	29	5	17
5VO	3	6	1	17
5VO	4	30	5	17
5VO	5	20	2	10
5VF	1	22	2	9
5VF	2	26	4	15
5VF	3	20	2	10
5VF	4	14	2	14
5VF	5	26	4	15
Control Pinyon-Juniper 6VO	1	27	4	15
6VO	2	0 Bare under tree		
6VO	3	18	4	22
6VO	4	16	3	19
6VO	5	0 Bare under tree		
6VF	1	9	1	11
6VF	2	16	2	13
6VF	3	10	2	20
6VF	4	22	3	14
6VF	5	13	1	8

TABLE III C-2b

SNOW SURVEY Cont.
JANUARY

SITE DESCRIPTION	SAMPLE NO.	DEPTH OF SNOW (cm)	WATER CONTENT (cm)	DENSITY %
South facing slope at PL gate Starting point 0' uphill	1	11	1	9
22'	2	12	2	17
44'	3	8	2	25
66'	4	6	2	33
Mouth of Sorghum	1	29	5	17
	2	18	4	22
	3	20	3	15
	4	22	3	14
	5	25	2	8
Mouth of W. Gulch	1	22	1	5
	2	20	3	15
	3	18	1	6
	4	21	3	14
	5	15	2	13
Valley Bottom Sage	1	21	2	10
	2	13	2	15
	3	10	1	10
	4	18	2	11
	5	21	2	10

TABLE III C-2b

SNOW SURVEY Cont.
JANUARY

SITE DESCRIPTION	SAMPLE NO.	DEPTH OF SNOW (cm)	WATER CONTENT (cm)	DENSITY %
North facing slope	1	26	4	15
	2	33	4	12
	3	33	6	18
	4	28	6	21
	5	32	6	19
West facing slope in Pinyon-Juniper	1	28	5	18
	2	24	6	25
	3	8	1	13
	4	12	2	17
	5	27	4	15
Valley Bottom Lepidium stand at USGS station				
E. side of Gulch stake 0'	1	28	3	11
Intervals of 40'	2	25	5	20
80'	3	24	3	13
120'	4	12	2	17
160'	5	24	5	21
200'	6	22	2	9
240'	7	23	2	9
280'	8	22	3	14
320'	9	15	3	20

TABLE III C-2b

SNOW SURVEY Cont.
JANUARY

SITE DESCRIPTION	SAMPLE NO.	DEPTH OF SNOW (cm)	WATER CONTENT (cm)	DENSITY %
E. side of Gulch stake 0'				
360'	10	21	3	14
400'	11	13	2	15
440'	12	0	0	0

TABLE III C-2c

SNOW SURVEY
FEBRUARY

SITE DESCRIPTION	SAMPLE NO.	DEPTH OF SNOW (cm)	WATER CONTENT (cm)	DENSITY %
Chained Pinyon-Juniper 1VF	1	0	0	0
1VF	2	6	1	17
1VF	3	8	4	50
1VF	4	9	3	33
1VF	5	11	3	27
1VO	1	0	0	0
1VO	2	0	0	0
1VO	3	0	0	0
1VO	4	9	2	56
1VO	5	0	0	0
Chained Pinyon-Juniper Control 2VF	1	15	5	33
2VF	2	27	7	26
2VF	3	24	7	29
2VF	4	30	8	27
2VF	5	32	9	28
2VO	1	0	0	0
2VO	2	0	0	0
2VO	3	16	9	56
2VO	4	0	0	0
2VO	5	0	0	0

TABLE III C-2c

SNOW SURVEY Cont.
FEBRUARY

SITE DESCRIPTION	SAMPLE NO.	DEPTH OF SNOW (cm)	WATER CONTENT (cm)	DENSITY %
Plateau Sage 3VF	1	20	4	20
3VF	2	23	2	9
3VF	3	22	4	18
3VF	4	9	4	44
3VO	1	22	8	36
3VO	2	26	6	23
3VO	3	23	8	35
3VO	4	19	4	21
Valley Sagebrush 4VF	1	9	8	89
4VF	2	30	7	23
4VF	3	12	2	17
4VF	4	9	6	67
4VF	5	0	0	0
4VO	1	6	5	83
4VO	2	0	0	0
4VO	3	0	0	0
4VO	4	0	0	0
4VO	5	4	4	100
Pinyon-Juniper near Sorghum Gulch 5VF	1	20	8	40
5VF	2	10	3	30

TABLE III C-2c

SNOW SURVEY Cont.
FEBRUARY

SITE DESCRIPTION	SAMPLE NO.	DEPTH OF SNOW (cm)	WATER CONTENT (cm)	DENSITY %
P-J near Sorghum Gulch cont.				
5VF	3	14	3	21
5VF	4	0	0	0
5VF	5	10	2	20
5VO	1	0	0	0
5VO	2	30	8	27
5VO	3	0	0	0
5VO	4	27	13	48
5VO	5	30	10	33
Pinyon-Juniper Control				
6VF	1	12	6	50
6VF	2	13	8	62
6VF	3	7	2	29
6VF	4	12	8	67
6VF	5	9	6	67
6VO	1	15	8	53
6VO	2	15	6	40
6VO	3	30	4	13
6VO	4	12	4	33
6VO	5	28	4	14

TABLE III C-2c

SNOW SURVEY Cont.
FEBRUARY

SITE DESCRIPTION	SAMPLE NO.	DEPTH OF SNOW (cm)	WATER CONTENT (cm)	DENSITY %
Chained Pinyon-Juniper, animal grid ME7	1	0	0	0
ME7	2	0	0	0
ME7	3	0	0	0
ME7	4	0	0	0
ME7	5	0	0	0
South-facing slope at PL gate ME8	1	0	0	0
ME8	2	0	0	0
ME8	3	0	0	0
ME8	4	0	0	0
ME8	5	0	0	0
Mouth of Sorghum ME9	1	0	0	0
ME9	2	0	0	0
ME9	3	4	1	25
ME9	4	0	0	0
ME9	5	10	3	30
Mouth of W. Stewart ME10	1	0	0	0
ME10	2	0	0	0
ME10	3	0	0	0
ME10	4	0	0	0
ME10	5	0	0	0

TABLE III C-2c

SNOW SURVEY Cont.
FEBRUARY

SITE DESCRIPTION	SAMPLE NO.	DEPTH OF SNOW (cm)	WATER CONTENT (cm)	DENSITY %
Bunchgrass - West Stewart ME11	1	0	0	0
ME11	2	0	0	0
ME11	3	0	0	0
ME11	4	0	0	0
ME11	5	0	0	0
Valley Bottom Sage W. Stewart				
ME12	1	0	0	0
ME12	2	8	3	38
ME12	3	0	0	0
ME12	4	10	3	30
ME12	5	0	0	0
North-facing slope				
ME13	1	42	13	31
ME13	2	40	15	38
ME13	3	26	9	35
ME13	4	22	7	32
ME13	5	32	8	25
West-facing slope in Pinyon-Juniper				
ME14	1	25	12	48
ME14	2	15	12	80
ME14	3	0	0	0

TABLE III C-2c

SNOW SURVEY Cont.
FEBRUARY

SITE DESCRIPTION	SAMPLE NO.	DEPTH OF SNOW (cm)	WATER CONTENT (cm)	DENSITY %
West-facing slope in Pinyon-Juniper Cont. ME14	4	1	1	100
ME14	5	30	8	27
Bottom of Cotton-wood ME15	1	16	3	19
ME15	2	26	8	31
ME15	3	16	7	44
ME15	4	14	2	14
ME15	5	13	3	23
ME15	6	24	5	21
ME15	7	12	4	33
ME15	8	24	4	17
ME15	9	0	0	0
ME15	10	0	0	0
ME15	11	0	0	0
Head of Sorghum ME16	1	36	16	44
ME16	2	32	9	28
ME16	3	40	8	20
ME16	4	34	12	35
ME16	5	32	7	22

TABLE III C-2c

SNOW SURVEY Cont.
FEBRUARY

SITE DESCRIPTION	SAMPLE NO.	DEPTH OF SNOW (cm)	WATER CONTENT (cm)	DENSITY %
Valley bottom - Scandard Lepidium				
ME17	1	30	9	30
ME17	2	12	3	25
ME17	3	12	2	17
ME17	4	15	2	13
ME17	5	14	3	21
ME17	6	16	5	31
ME17	7	17	7	41
ME17	8	6	2	33
ME17	9	14	3	21
ME17	10	0	0	0
ME17	11	0	0	0
ME17	12	0	0	0

AERI PHOTOGRAPHIC STUDY

III D AERIAL PHOTOGRAPHIC STUDY

There are no second quarter activities to report for the Aerial Photographic Study. The February flight, previously scheduled, was cancelled. It was determined that a major flight during the winter was of little value biologically and of no value to geology or engineering. The winter flights made for deer counts will provide sufficient information for other aspects of the biological program. A flight is currently being scheduled for the 1975 growing season.

First flight photography is being used extensively in the Soils Survey, the Terrestrial Vegetation Studies, and the Geological Studies.

74-669

CULTURAL AND PALEONTOLOGICAL RESOURCES

Federal Oil Shale Lease TRACT C-b

by Calvin H. Jennings

prepared for
Atlantic Richfield Company, Operator

March 1975

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FIGURES

CULTURAL AND PALEONTOLOGICAL RESOURCES OF FEDERAL OIL SHALE TRACT C-b, RIO BLANCO COUNTY, COLORADO

Abstract

As a part of the environmental studies made in preparation for the development of Federal Oil Shale Lease Tract C-b, a program of archaeological reconnaissance was undertaken in August 1974 to determine the nature and significance of cultural resources that may be present on the tract. This project supplements a less intensive reconnaissance of the tract carried out in 1973. In both the 1973 and 1974 studies, the field work and analysis were carried out under the supervision of Calvin H. Jennings, Laboratory of Public Archaeology, Colorado State University.

The 1973 project located one prehistoric site and one site of historic affinity. Both sites are outside but immediately adjacent to the tract boundaries. The 1974 reconnaissance recorded three more prehistoric sites, all within the tract's perimeter. In addition, a number of isolated artifacts were collected in the 1974 effort, and two paleontological sites were reported by members of a geological team associated with a core-drilling program.

The significance of the paleontological resource is best determined by trained paleontologists, but the discovery of the remains of long-extinct fauna does indicate the presence of a previously unrecognized resource in the tract vicinity. The cultural materials indicate human occupation of the vicinity from about 5000 B.C. to the mid-twentieth century. The cultural resource is regarded as having scientific value in that the information present in some of the sites

on the tract may help to clarify our understanding of man's use of the Piceance Basin over a period of several thousand years. However, none of the sites are deemed to have either national or regional significance when compared with other sites already recorded for the region. No nominations for the National Register of Historic Sites will be made from the inventory of Tract C-b sites.

Mitigation of the impact of development is recommended in the form of test excavations at two of the prehistoric sites, 5RB136 and 5RB146, if they are to be directly endangered by tract development. If no direct disturbance of the sites is anticipated, the only action necessary will be the posting of the sites to warn off vandals and others who might damage or destroy the sites. No further action at the remaining three sites is necessary. It is also recommended that the areas immediately adjacent to the tract (up to a distance of 1 kilometer) be systematically reconnoitered in the event that development of the tract is imminent, so their site content can be better estimated. There is a strong likelihood of secondary impact in the areas surrounding the tract, and some effort should be made to clarify the nature of the cultural resources in the area before they are disturbed.

No explanation is offered here for the lower site density of Tract C-b as compared with other parts of the Piceance Basin. Hypotheses concerning the differential in prehistoric settlement must await completion of the description of the resource base in other parts of the basin and the analysis of the settlement pattern in those areas.

I

INTRODUCTION

LOCATION

The study area, Federal Oil Shale Tract C-b, is in Rio Blanco County, Colorado, about 20 miles west of the community of Rio Blanco. The tract comprises about 5100 acres south of Piceance Creek and between Willow Creek and Stewart Gulch (Figure 1).

PROJECT ORGANIZATION

The baseline study of the cultural resources of the Oil Shale Tract C-b was initiated by the Laboratory of Public Archaeology at Colorado State University at the request of Woodward-Envicon, environmental consultants, on behalf of Atlantic Richfield Company, Operator. The study was undertaken to fulfill the Lease Environmental Stipulations set forth by the Bureau of Land Management (USDI, 1973).

> *Sec. 6. Historic and Scientific Values.* (A) *Cultural Investigations.* The Lessee shall, prior to construction or mining, conduct a thorough and professional investigation of any portion of the Leased Lands to be used, including, but not limited to, those to be used for mining, processing, or disposal operations or roads, for objects of historic or scientific interest, including, but not limited to, Indian ruins, pictographs and other archeological remains. The Lessee shall report the results of these investigations of the Mining Supervisor before commencing construction and mining operations.

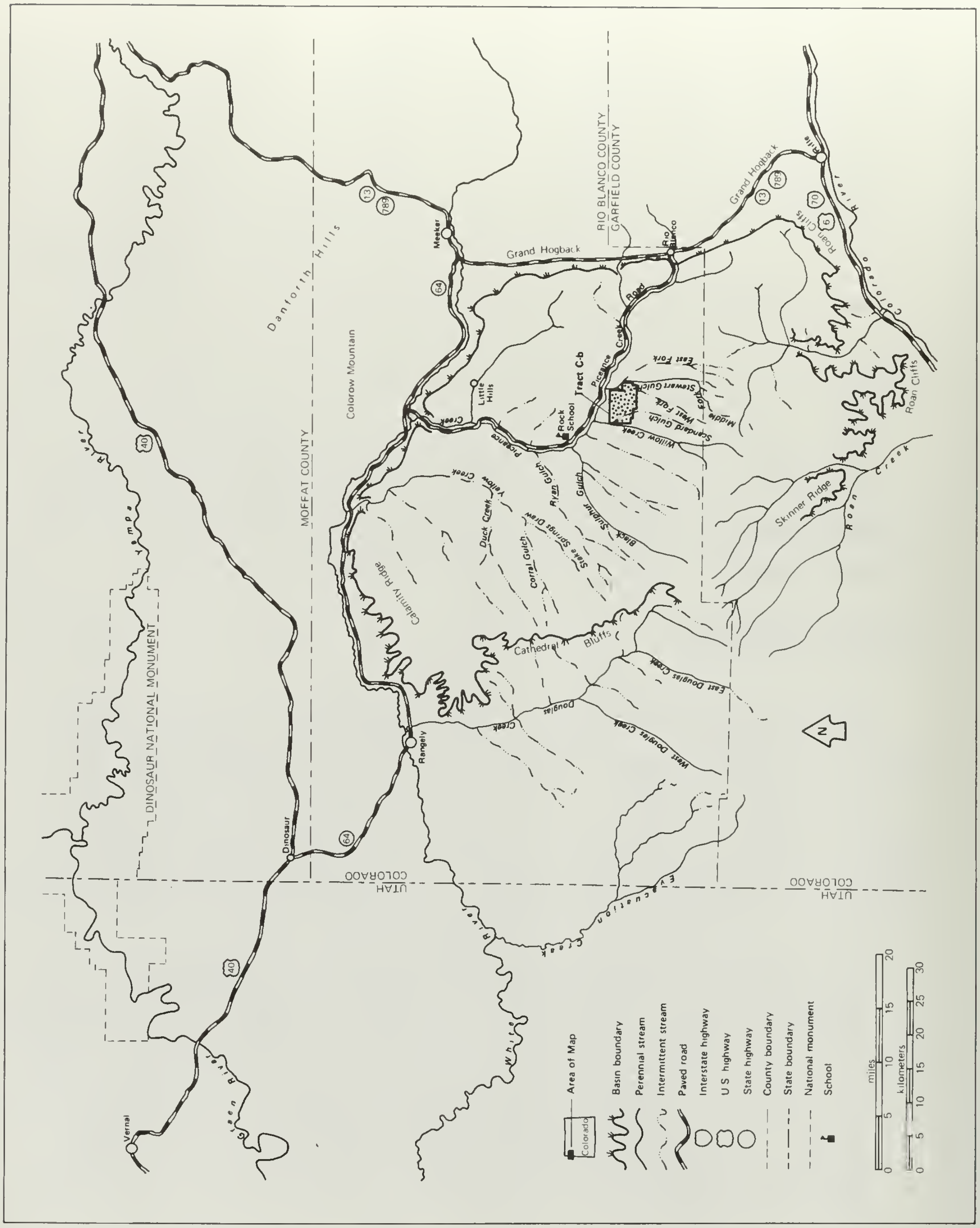

Figure 1. THE PICEANCE BASIN AND SURROUNDING AREA

(B) *Objects of Historic or Scientific Interest.* The Lessee shall not in any activities under this lease appropriate, remove, injure, deface, or alter any object of antiquity, or of historic, prehistoric, or scientific interest, including, but not limited to, Indian ruins, pictographs, and other archeological remains. Where a question exists as to whether or not an object is of historic, prehistoric, or scientific interest or is an object of antiquity, the Lessee shall report to the Mining Supervisor for a final determination of which he shall inform the Lessee without unnecessary delay.

The purpose of the project was to identify sites of past human activity in the tract environs, to relate them to contemporaneous activities in the region, and to assess the scientific value and historical significance of each site. This information will be used by Atlantic Richfield Company in preparing the final development plan so that valuable or significant resources are not lost but are instead preserved for future generations.

Initial planning was done in the early spring of 1974. The proposal for the study of the cultural resources of the tract was made to Atlantic Richfield Company in May 1974. An orientation meeting was held in Grand Valley, Colorado, in July 1974. Final clearance to begin the archaeological study was given on August 1, 1974, at which time the following individuals, under the supervision of the author, C.H. Jennings, began an intensive investigation of the tract. The field crew included Morris R. Anderson, Gerald A. Bair, William I. Berg, Donna C. Daniels, Catherine L. Holder, Anne P. McNamara, Janet L. Pierson, Kim G. Pinketon, and David A. Weber. Bair and Berg have had extensive field experience both in the Piceance Basin and in other areas of North America. These two men assisted Jennings in the supervision of the crew. The rest of the crew members have completed at least one season's field work in archaeology. All had worked in the Piceance Basin and were familiar with the local archaeological situation.

Field work was conducted between August 1 and 11, 1974. A total of 56 man-days of effort were utilized and 2640 acres were intensively examined. The work was concentrated in approximately 52 percent of the total tract area of 5094 acres. The field work was carried out under Federal Antiquities Permit 74-CO-055, issued through the Craig District of the Bureau of Land Management.

A quadrat system which utilizes quarters of public land survey sections as the sampling unit was used for the field survey. The quadrats were laid out in a checkerboard pattern rather than being randomly selected, on the premise that a more representative pattern of site distribution could be gained by use of the regularized distribution over the tract area. A description of the methods employed is given below under Reconnaissance Methods.

The results of the examination of Tract C-b include the discovery of three previously unrecorded sites within the tract boundaries. These sites were designated 5RB136, 5RB146, and 5RB147 in the Archaeological Survey of Colorado site inventory. Sites 5RB136 and 5RB146 are in the northeastern portion of the tract and 5RB147 is in the northwestern corner (Figure 2).

In addition, two sites were recorded in an earlier study of the vicinity of the tract (C. H. Jennings, 1974): 5RB67, in the Middle Fork of Stewart Gulch in the NE¼ of Section 21; and 5RB69, near the confluence of Willow Creek and Piceance Creek in the NW¼ of Section 36, T2S, R97W. No other sites have been recorded in the immediate vicinity of Tract C-b, owing in part to the lack of systematic archaeological reconnaissance in the area.

OTHER ARCHAEOLOGICAL STUDIES

The only other archaeological work done in the Piceance Basin, prior to 1974, was carried out by Colorado State University in cooperation with Thorne Ecological Institute of Boulder, Colorado.

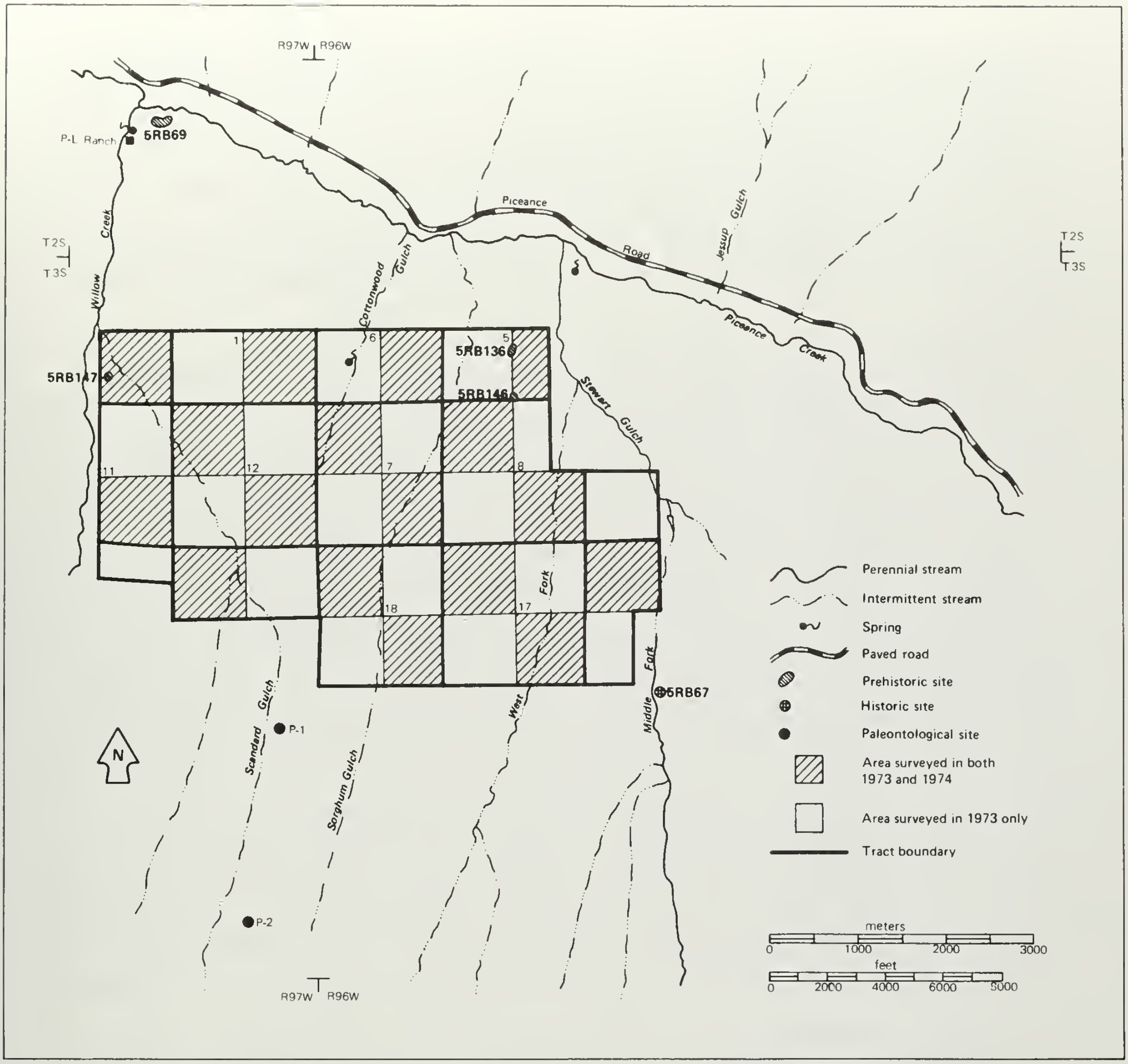

Figure 2. ARCHAEOLOGICAL AND PALEONTOLOGICAL SITES, TRACT C-b AND VICINITY

The project was done as a part of the Regional Oil Shale Study for the Colorado Department of Natural Resources (Thorne Ecological Institute, 1974). Tract C-b was given a reconnaissance-level examination by the CSU archaeological team during the summer of 1973 (C. H. Jennings, 1974). The sites located in this initial examination are the ones mentioned above and are located outside the tract boundaries.

During the summer of 1974, with the acceleration of interest in the development of energy resources in the United States, there was an increase in activity in the Piceance Basin. Studies of the region's cultural resources grew in response to the requirements for cultural resource conservation associated with federal and state land management statutes. During 1974 field work continued on the Regional Oil Shale Survey, and the University of Denver and Southern Colorado State College also placed survey crews in the region. The University of Denver team was working under contract with the operators of the Oil Shale Tract C-a and concentrating its efforts in the Corral Gulch-Box Elder Gulch area of the basin. The team from SCSC was working under contract with Superior Oil Company in the area between Yellow Creek and Piceance Creek on the northern edge of the Piceance Basin. Since reports from these two efforts are not yet available, their results cannot be compared with the finding of the Tract C-b survey.

The reexamination of Tract C-b in 1974 was conducted to verify the results of the 1973 study. As noted above, three new sites were located which had been missed during the 1973 reconnaissance. The disparity between the two efforts results primarily from the difference in levels of intensity of ground examination between the two projects. The 1973 project covered the Tract C-b area and the area between the northern boundary of the tract and Piceance Creek, utilizing an effort of 30 man-days. Roughly a third of the area examined in 1973 was

reexamined in 1974 utilizing an effort of 56 man-days. Clearly, the 1974 effort reported here was much more intensive and therefore more likely to discover the relatively small and difficult-to-detect sites that are described below.

RECONNAISSANCE METHODS

Each of the sample quadrats was examined by a party of three or four people. The party began its coverage of the quarter-section at a section corner or a quarter-section marker. The party covered each of the quadrats in a series of sweeps made by walking abreast about 30 meters apart. This spacing, of course, varied with terrain and vegetation conditions. Areas with greater than 15 percent slope were not given intensive investigation, since previous surveys of similar slopes elsewhere in the Piceance Basin have failed to yield any material of interest (sheet erosion would have removed anything that might have been there).

All sites encountered were recorded on Archaeological Survey of Colorado site inventory forms (Appendix A). Surface collections were made without any attempt at systematization or standardization of area of coverage, since none of the sites had enough artifacts to warrant such procedures.

All the artifacts were catalogued in the Colorado State University system (Appendix B) and are presently stored there. Analysis was limited to simple morphological description, since no single potential type was represented by more than a single specimen.

II

ENVIRONMENTAL BACKGROUND

In order to understand man's activities in the Piceance Basin in antiquity it is necessary to outline the nature of the environment from which he extracted his raw materials and food and with which he had to cope in guaranteeing his continued survival in the region. Preindustrial man faced more immediate short-term environmental constraints than his modern counterpart. Because he had to be self-sufficient within a very limited geographic area, intimate knowledge of the resources of each microenvironmental unit within his reach was mandatory. Failure to realize the potential of each element of his environment meant either extinction or loss of the territory to some other group capable of exploiting the otherwise unrecognized potential of the area.

Preindustrial man's sensitivity to environmental constraints gives considerable value to general environmental information as a tool for reconstruction of ancient man's activities. Consequently, no discussion of the archaeology of a locality is complete without a description of the nature of the environment that points up those elements which may have had value to, and impact on, prehistoric man.

TOPOGRAPHY

The surface of Tract C-b is made up of a series of interfluvial ridges which trend basically north-south. The streams forming these ridges are moderately incised into the sandstone bedrock of the area.

The major drainages such as Willow Creek, Scandard Gulch, and the main stem and West and Middle forks of Stewart Gulch have formed steep-walled canyons, the bottoms of which are 100 to 250 feet below the intervening ridge crests. There are also drainages of intermediate depth, such as Cottonwood Gulch and Sorghum Gulch and a number of lesser unnamed gulches which are generally less than 150 feet below the adjacent ridge tops but which contribute to the rolling nature of the landscape.

The location of the tract south of Piceance Creek and the general downward slope of the bedrock from south to north in that locality place the higher elevations on the tract at its southern boundary and the lower elevations on the north side of the tract. The highest elevation on the tract is at the southern boundary on the ridge between Sorghum Gulch and the West Fork of Stewart Gulch, where the crest elevation is slightly over 7100 feet. The lowest elevation on the tract is at the mouth of Scandard Gulch at slightly over 6400 feet above sea level. Outside the tract area is Piceance Creek which has flood-plain elevations ranging between about 6260 feet above sea level at Willow Creek on the west to 6360 feet at Stewart Gulch on the east.

Generally, the topography of the area can be described as having rounded to flat ridges separated from one another by moderately deep canyons and gulches. The ridges trend north-south and drop gently downward from high points in the south to lower elevations in the north. The ridges terminate outside the tract to the north in bluffs overlooking Piceance Creek. The drainage bottoms are deeply dissected by arroyos which have cut through alluvial fans encroaching across the floors of the canyons. This is most evident in Stewart Gulch and its various forks, in Scandard Gulch, and in Willow Creek.

Tributaries to the northward-flowing drainages, which empty into Piceance Creek, have scalloped the ridge margins, making embayments in the canyon walls along the major drainages. These features give local deviation from the general pattern described above and serve to increase the varieties of topographic exposures on the tract.

In relation to the needs of prehistoric man, the topography of the tract would have provided excellent sites for well-sheltered camps that would receive ample sunlight. The ridges and drainages alike would have provided easy routes of travel from Piceance Creek to the Roan Plateau on the south. East-west travel in this part of the Piceance Basin would have been most likely directed along Piceance Creek, but the ridges and shallow canyons south of the stream's course would certainly have not provided a major barrier to communication.

GEOLOGY

The geology of Tract C-b would have been of relatively little interest to the aboriginal users of the area, except for the uppermost element in the bedrock stratigraphy and the effects that the structure of the basin and the permeability of the beds underlying the surface would have had on the availability of the surface water.

The uppermost member of the basin's deposits is a buff to light brown sandstone with elements of marlstone, siltstone, and shale (Cashion and Donnell, 1974:G3; Donnell, 1961:857-858). This deposit was originally assigned to the Green River Formation (Bradley, 1931). However, reexamination of the lithology and shale oil contents of the Parachute Creek member and Evacuation Creek member and comparison with the A horizon of the Uinta Formation have led Cashion and Donnell (1974) to reject the validity of the association of the buff sandstone with the Green River Formation in favor of placing it in the lower

portions of the Uinta Formation. Consequently, the term used in this report for the buff cap overlying the Parachute Creek member and contributing to the rounded hilly topography described above will be "Uinta A."

The Uinta A is of importance to the student of past human behavior in the study area because of its potential, or lack of it, for providing raw materials for tool manufacture. The sandstone is also important because of the nature of its weathering characteristics and the effect they have on the availability of natural shelter in the region.

The sandy nature of much of the Uinta A that is exposed in the tract vicinity makes it a suitable material for use as milling stones for pinyon nuts, acorns, and various grass seeds. We have some evidence of such use of the sandstone for these purposes. Given the wide distribution of the source material over the basin, this evidence is much more limited than was expected. It seems likely that the relative softness of the stone and its tendency to wear rapidly may have made it a less desirable material for the preindustrial inhabitants of the region.

Clastic inclusions of cryptocrystalline materials suitable for stone tools are rare in the Uinta A. Consequently, the aboriginal users were forced to either travel or trade for the raw materials from which their arrowheads, scrapers, drills, and knives were made. A few amateur collectors have reported finding tools chipped from oil shale. These tools are very rare, and if we are to accept rarity in this case to imply a lack of popularity or importance then we can reject the Parachute Creek exposures where the oil shale is accessible as being economically important in prehistoric times.

The A member of the Uinta Formation lacks the capacity to form large rock shelters or caves which could have been utilized by the hunters and gatherers who exploited the resources of the basin before the coming of the Euro-Americans. Consequently, there is little

likelihood of finding sites in the region that have the well-preserved perishables such as leather goods, basketry, feather work, and the like, that are usual in rock shelters in areas with a similar climate. The lack of rock shelters in the Uinta A also has implications for the way in which campsites were positioned. The presence of other sorts of natural shelter, such as prominent elevations and dense stands of trees, would have become a more important consideration in site selection.

At another level, the geology is of importance in understanding the historical significance of the Tract C-b locality. The problem lies with a time period considerably predating the earliest possible date for man's entry into the region. The era in question is the time when the Uinta A was being laid down in the Middle Eocene (Osborne, 1929) or roughly between 55 and 60 million years ago. The Uinta A beds of the area west of Rangely, Colorado, along the White River were originally identified by O.A. Peterson (Osborn, 1895:72-74). The beds were found to be nonfossiliferous, and recent geologic studies in the Piceance Basin (Donnell, 1961:858) did nothing to change that opinion. However, other formations of similar age to the Uinta A have produced large mammalian assemblages, so the presence of fossil materials is to be expected, or at least should be considered. As will be seen below, the fact that such material has been recovered indicates that the barren Uinta A deposits were so only because of the limited amount of work that has been done on the region's paleontology.

HYDROLOGY

The hyrologic aspect of the Tract C-b environment is one of the most important elements in prehistoric and early historic man's utilization of the region. Unfortunately, the hydrologic situation in any area has great potential for variation over time spans of interest

to archaeologists. Springs can rise and dry up within a few years; streams dependent on the same sources of moisture as the springs must also then fluctuate. Because of such variability, considerable caution must be used in applying knowledge about present hydrologic conditions to the past, especially to the distant past.

Recently there has been considerable interest in the Piceance Basin's hydrology because of the bearing that groundwater quality and quantity will have on the development of energy extraction industries in the region. Consequently, there is abundant information on the nature of the basin's ground- and surface waters. The work of the U.S. Geological Survey (Coffin et al., 1968, 1971) and Meiman (1973) for the Regional Oil Shale Study indicate that surface water is available year round and that it is abundant in the early spring following the melt of the winter snow. Convectional thunderstorms in the summer can also bring short periods of abundant water.

In the immediate vicinity of the tract are three drainages of potential prehistoric significance: Piceance Creek, Stewart Gulch, and Willow Creek (Figure 2). Unfortunately, records of stream flow are not available for either Stewart Gulch or Willow Creek, and the gauging stations for Piceance Creek are too distant from the mouths of these two streams to permit inference of their discharge rates and seasonal flow patterns. Casual observations made by people associated with the archaeological surveys done in the tract area during 1973 and 1974 indicate that Willow Creek does flow year round, at least under the present climatic regime and water table conditions. The flow of water in Stewart Gulch seems much less stable. Surface flow has been observed in the Middle Fork near the southeastern corner of the tract. The Jessup Gulch quadrangle 7.5-minute topographic map indicates that there is permanent flow in this portion of the drainage. Also, the *Hydrologic Investigations Atlas* (Coffin et al., 1971) indicates the presence of a spring along the Middle Fork about 2 miles south of the tract supporting this flow. However, the atlas indicates that all

the forks of Stewart Gulch, and Willow Creek as well, are ephemeral streams. To reconcile the archaeologist's casual observations with those of the professional hydrologist is beyond the scope of this study, but it is our inclination to accept the evidence of our own observations and assume that, at least in recent years, surface water has been available on segments of Stewart Gulch and its Middle Fork and on Willow Creek.

The map prepared by Coffin and his associates (1971) also indicates the presence of springs in the following localities (Figure 2): near the mouth of Willow Creek in the NE¼NE½ of Sec. 35, T2S, R97W; on Willow Creek about 2 miles above the confluence with Scandard Gulch in the NW¼SW¼ of Sec. 14, T3S, R97W; on Cottonwood Gulch in the NE¼SW¼ of Sec. 6, T3S, R96W; and at the mouth of Stewart Gulch in the NE¼NE¼ of Sec. 5, T3S, R96W. These localities may have been occupied more regularly than areas more distant from water supplies.

The uncertain elements in the groundwater picture have been outlined. Given more moist conditions in the region, it is likely that at least some, if not all, of the sources so far described would have provided supplies of readily accessible surface water for early users of the basin. Some of these sources have at least been detectible to the researchers working on the area's hydrology and probably would have also been of at least some use to early man during times when hydrologic conditions in the area approximate those of the present. Consequently, we would expect to find elements in the distribution pattern of prehistoric communities which reflect the availability of these water sources at various times throughout the period of human occupation of the tract area. One element of possible disruption of this response to the marginal sources of water is in the perennial flow of Piceance Creek, located only about 900 meters north of the tract at its nearest approach. Marginal water sources may have had relatively little value in the context of the larger, though seasonally highly

variable flow in Piceance Creek (Meiman, 1973:5). Domestic settlements may have been situated for the best access to Piceance Creek, given the constraints of shelter requirements and access to other critical resources. Piceance Creek gains in flow in the vicinity of Tract C-b (Coffin et al., 1971), indicating that perhaps even in periods of reduced precipitation the surface flow in the creek near the tract was great enough to provide adequate water for the low population densities characteristic of preindustrial societies in other parts of the world.

CLIMATE

Climatic information for the Piceance Basin in general is quite limited. There is a series of records (1890-1974) from Rangely, about 36 air miles northwest of Tract C-b, and from Meeker, about 22 air miles to the northeast. There has been no systematic year-round record keeping in the basin itself except at the Little Hills Game Experiment Station about 13 air miles north of the tract, where records of daily maximum and minimum air temperatures have been kept since 1946. Measurements of noon wind conditions have been made at Little Hills since 1971 for use on the fire weather network but no record of these measurements has been kept.

Marlatt (1973:4) also reports that records have been kept from an unofficial weather station at the Rock School, located at the confluence of Black Sulphur Gulch and Piceance Creek, and at a number of other special-purpose stations operated by private parties. He feels that the standardization of station layout and instrument calibration among these various stations was not adequate to permit comparison of the various sets of records. He also points out that in many cases the stations were so established as to have been significantly influenced by topography, vegetation, and cultural features and therefore produced biased records.

Precipitation figures from Little Hills show a mean annual precipitation of 12.90 inches (328 mm) for a 20-year period of record between 1951 and 1970; between a third and a half of the annual total is probably derived from snowfall (Marlatt, 1973:5, 6). Snowfall tends to be distributed fairly evenly over the region, though the actual amounts vary with elevation. The rainfall amounts for any given locality in the basin vary considerably from year to year. The summer precipitation comes primarily from convectional thunderstorms rather than regional storms; but the thunderstorms are unreliable sources of precipitation for any specific area because they are so concentrated. The basin's topography also undoubtedly plays a role in directing the paths of these storms.

As with the hydrology, the absence of adequate records forces the use of casual observations made without either adequate technical training or suitable observational techniques in applying what documentation exists for Tract C-b and vicinity. Two years of observation during the summer months without adequate documentation leave the impression that the Tract C-b locality generally receives more precipitation than the Little Hills area. This may be in part due to the slightly higher elevation of the tract vicinity relative to the Little Hills station.

Whatever the actual numerical difference, annual precipitation at Tract C-b probably will not be above 15 inches (381 mm) on the average for any extended period of measurement.

Air temperature is somewhat more predictable. The Little Hills Station, for the 1951-1970 period of record, had an annual mean of 42.7°F (5.9°C). The roughly 400-foot (122-meter) difference in elevation between this station and the Tract C-b vicinity would account for a minor difference in air temperature. The average seasonal extremes for Little Hills are 21.2°F (-5.9°C) in January and 65.8°F (18.8°C) in July (Marlatt, 1973:9).

The climate in the Piceance Basin, and specifically the Tract C-b vicinity, can be classified as mid-latitude steppe. Conditions are generally cool and semiarid. The growing season for the area, estimating from Marlatt's study (1973:11), must be less than 100 days and more than 45 days—and is probably closer to the former. The winters can be severe, with long periods of low temperatures. The summers can be warm, but temperatures seldom go above 100°F (38°C). In general, the climate in the region is not severe enough to have limited human occupation, except perhaps during the period from late or mid-December through February. The climate may, however, have had considerable impact on the kinds of subsistence activities pursued by the prehistoric imhabitants.

SOILS

The soils of the region have been studied by Fox (1973); they are of interest to the archaeologist because of their impact on agriculture. Fox (1973:19) describes the soils as being predominantly cool to cold and calcareous or alkaline, except where there is coniferous vegetation and an acid condition exists on the surface.

Regional soil conditions are not suitable for most agricultural use. The upland soils are thin and are too low in temperature. The alluvial soils along the drainages are warmer and permit the cultivation of alfalfa or timothy where adequate irrigation water is present. Generally, however, the area has a low agricultural potential.

VEGETATION

The tract vegetation represents a resource which must have been of great importance to the aboriginal users of the area. Vegetable products were a major part of the diet of the early occupants of western North America. In addition, plants provide a wide variety of raw materials from which tools, medicines, and nonutilitarian objects were made.

Some of the vegetation present in the basin is of well-known economic importance in the aboriginal exploitative systems.

Ferchau (1973:1) describes the vegetation pattern in the basin as being "mosaic-like." He sees in the region a great deal of floral diversity and, therefore, a considerable diversity and abundance in the animals of the region. Ferchau identified eleven different plant communities in the basin. He identified these communities as the following: Douglas fir, spruce-fir, aspen, mixed shrub, big sagebrush, mountain mahogany, greasewood, wild rye, Indian rice grass, pinyon-juniper, and Cathedral Bluffs. Serviceberry, Gambel oak, and snowberry dominate the mixed shrub community. The pinyon-juniper community is seen to vary from almost pure stands of pinyon to stands with one or two species of juniper and no pinyon. The proportions of the two genera are highly variable, depending on soil development, aspect, and availability of moisture.

Tract C-b is represented mainly by pinyon-juniper, chained pinyon-juniper, big sagebrush, mixed shrub, and bunchgrass communities. The pinyon-juniper and mixed shrub communities are of the greatest interest here because of their potential economic value to societies that subsisted by hunting and gathering. In the Tract C-b vicinity the natural vegetation pattern has been recently disrupted by the destruction of large portions of the pinyon-juniper community on the ridge tops. The destruction was carried out by the Bureau of Land Management as part of a range improvement project in the basin. The situation was further complicated by the extraction of the pinyon from the tract area by a group of commercial woodcutters for sale as firewood. The woodcutting makes the estimation of the density of the total stand and the proportion of pinyon somewhat less reliable than would otherwise be the case. However, it is readily apparent to even the casual visitor to the tract that the stand of trees was quite dense and that pinyon accounted for a considerable portion of the total stand.

Before the chaining of the pinyon-juniper from the ridges, the mixed shrub community accounted for much less of the tract area than is the case at present. The big sagebrush community is represented along the bottoms of the canyons, where it has been disturbed in places by clearing for irrigated pastures and hay meadows.

The aboriginal situation is not easily reconstructed from what we see in the present distribution of flora in the tract area. The recent disturbance of the plant communities by man and the introduction of livestock have no doubt changed the vegetation of the area to some extent. Also, human encroachment on mule deer ranges in areas such as the White River Valley may have served to increase the deer populations in the Piceance Basin to anomalously high levels, thereby increasing grazing pressures on the plant communities.

The most reasonable statement that can be made concerning the plant resources of the tract area is that the same species present now were quite likely present in the recent past. Though their proportionate representation cannot be reliably reconstructed from the presently available data, the availability of the resources can be determined.

The most important of these resources was most likely the pinyon crop. The nuts of the pinyon were widely exploited over the pinyon's entire range, and they still constitute an important resource to many American Indian groups. The nut is an excellent source of protein and provides 3250 kilocalories per pound in food energy. The pinyon crop provides a storable food source at a time of year when other resources are less abundant. Since the nut requires no complicated processing or elaborate equipment for its storage, it is readily available for the winter months when other food sources are restricted or nonexistent.

The serviceberry crop was also of some importance to the Indians of Colorado. The berry was eaten unprocessed or was pounded together with meat in a form of pemmican.

The pinyon and serviceberry crops, then, would have provided at least some attraction for early man in the Piceance Basin. These plants are available on Tract C-b and vicinity and help to account for the presence of prehistoric sites in the locality. Because this attraction would have been only seasonal, occupation of the area would have fluctuated accordingly.

WILDLIFE

Wildlife species in the Piceance Basin are abundant and highly varied (Cringan, 1973). There are 82 species of mammals and 258 species of birds reported for the Piceance Basin; fish and other cold-blooded vertebrates appear in smaller numbers and with less variety.

The mammals include 27 species which would have been of value to preindustrial man. Horses were introduced to the basin in relatively recent times and would not have provided a resource for any except the most recent prehistoric inhabitants of the region. Even for these later inhabitants of the area, Tract C-b and vicinity would have held no interest with respect to wild horses, since the tract is well outside the present range of the wild herds. Bison are less well understood. There was a herd present in the basin as late as the summer of 1973. They had been introduced by the Colorado Division of Wildlife and were removed late in 1973 or early in 1974 after numerous complaints from local ranchers. Whether bison were present in the region prior to this time is not known. The area provided good range for the introduced herd, and earlier bison would probably have done reasonably well in the area.

Aside from the bison and the wild horse, the rest of the economically significant mammals were all likely present in the basin in prehistoric times and would have been accessible in the Tract C-b vicinity. Mule deer are extremely abundant now, and though the present

numbers may be somewhat affected by the reduction of their former winter range outside the basin, it seems likely that the ancient winter deer populations were comparable with those of the present. It has been widely reported that the basin now supports the largest winter deer herd in North America. Elk also winter in the basin, but their populations do not reach the magnitude of the deer populations.

Waterfowl, grouse, doves, and possibly even turkeys, are also part of the economically significant fauna. Their numbers in prehistoric times cannot be easily reconstructed, but they were most likely part of the resource base for aboriginal man.

Faunal resources for Tract C-b and vicinity, then, would have been adequate to permit at least seasonal if not year-round use by hunters and gatherers. None of the game animals noted by the biologists lend themselves to mass hunting except the hares and rabbits, and these only during periods of population explosion. Consequently, we expect to find no use of the bluffs, canyon walls, or arroyos as jumps, pounds, or drives. Hunting in the region would have been based on individual rather than group effort and would not have encouraged the formation of large groups for any purpose except possibly rabbit drives.

SUMMARY

This brief description of the environmental background of the Piceance Basin and Tract C-b vicinity indicates that there are no reasons why prehistoric man would have been prevented from occupying the region, and the tract vicinity in particular. In fact, there are some elements in the area's environment which would have encouraged at least seasonal use of the tract and the immediately adjacent areas.

Surface water seems to be available throughout the year, though there are considerable seasonal fluctuations. Raw materials for most

kinds of stone tools are absent from the region, but wood and various animal products are readily available now and probably were so in the past. The climatic regime, if similar to that of the present, would have placed a premium on shelter during the winter months. During other parts of the year people could have either done without shelter or made do with only the most rudimentary artificial windbreaks.

Dietary resources are varied and relatively plentiful at the present and in all probability were so in recent prehistoric times. The late summer and fall is now the period of greatest abundance and easiest procurement, and most likely was in the past as well. At that time of year the berry and pinyon crops are ripe and deer and elk move into the region from their summer ranges. Water supplies are most limited at that time of year but begin to increase in late fall; this may have been the major factor limiting human population density.

Generally, Tract C-b and its immediate vicinity are similar to other parts of the Colorado Plateaus physiographic province. The Colorado Plateaus have had a lengthy and varied history of human occupation. The resources of the Piceance Basin are nearly identical to those of such areas as the Coconino Plateau and the Defiance Plateau of northern Arizona. These two localities both supported occupation by humans at least as early as 2000 B.C. and were the scenes of the rise of two different cultural traditions. The oil shale country of Colorado, then, may also be a culturally rich area.

III

PALEONTOLOGICAL RESOURCES

Prior to this study it was believed that the Piceance Basin did not have any paleontological resources. However, geological field workers carrying out other studies discovered mammalian fossils at two different places in the vicinity of Tract C-b (Figure 2). The fossils were forwarded to the author, who then passed them on to the Director of the University of Colorado Museum, Dr. Peter Robinson. Dr. Robinson is a trained paleontologist who has considerable experience in western Colorado.

Robinson has reported (personal communication) that one of the fossils is an as-yet-unidentified mammal and that the other is apparently the "head of a femur of a Uintathere, probably *Uintatherium*," but he goes on to caution that more detailed studies are necessary before a definite identification can be made.

This evidence indicates that Tract C-b does have paleontological potential. The most obvious facet of the resource is that it may help to further clarify the historical geology of the region. The presence of *Uintatherium* in the buff sandstone capping the tract locality would serve to further substantiate the redefinition of the Green River Formation by Cashion and Donnell (1974).

The only recommendation we feel qualified to make is that a trained paleontologist examine the specimens recovered thus far and formulate a conservation plan. Archaeologists are not properly trained to engage in paleontological work.

IV

SYNOPSIS OF THE REGION'S CULTURES

PALEOINDIAN PERIOD: ? - 7000 B.C.

Man may have entered the New World as early as 30,000 years ago, near the end of the last glacial period of the Pleistocene. He must have been heavily reliant on hunting for his subsistence, with vegetable products playing a relatively minor role. The animals hunted included many species now extinct, such as the Columbian mammoth and *Bison antiquus*. Reliance on migratory herd animals placed a high premium on community mobility, and the Paleoindians followed a nomadic way of life. The remains of their settlements are difficult to detect and, once located, are usually associated with the remains of their prey.

There is no known evidence of Paleoindian occupation in the Tract C-b region. In fact, for all of western Colorado and the immediately adjacent portions of eastern Utah and southwestern Wyoming there are only five documented discoveries of artifacts or other remains which can be associated with this time period. The UP mammoth kill site in southern Wyoming (Irwin et al., 1962) indicates a possible Llano culture intrusion from the High Plains, but because none of the diagnostic Clovis points were found, the cultural affinities of the hunters are unclear. Also, several Folsom points have been reported from various parts of western Colorado (Bair et al., in preparation; Huscher, 1939:39; Steward, 1933; Wormington, 1955:120).

Consequently, we are left with a situation wherein there are indications that a Paleoindian site or sites may be found in the Piceance region but with no direct evidence of such in hand. However, the absence

of evidence of either proboscideans or bison in the Piceance Basin's fossil record--if we can use such negative evidence at all--indicates that the resources which would have attracted Paleoindians to the region were either not present or not present in large enough numbers to have met the hunter's subsistence requirements. From this evidence, or more precisely the lack of it, it seems unlikely that we will find little if any indication of Paleoindian occupation of the basin.

ARCHAIC PERIOD: 7000 B.C. - A.D. 1776

Climatic changes at the end of the Pleistocene reduced the range of the large animals and caused them to move northward. Along with the climatic and resource distribution changes, the human population of the New World was increasing. The resultant pressures placed an increased value on potential resources that had not been as intensively exploited during the preceding Paleoindian Period. Considerable generalization of subsistence activities took place, and items such as seed plants, various invertebrates, waterfowl, rodents, and the modern big game species took on considerably increased importance in the subsistence base of the Archaic Period occupants of the continent. In each region of the New World different resources were emphasized in the human diet, reflecting differences in availability. However, the pattern of exploitation was the same for all regions: intensive utilization of a wide variety of resources, usually following a seasonal round requiring a transient settlement system. The life style has been widely discussed, but the best-known contributions are those of J.D. Jennings (1957, 1964, 1974).

The sites of this period are generally much easier to locate and produce considerably larger inventories of artifacts than Paleoindian sites. Population of the New World was most likely greater, with an increased number of sites, and sites were reoccupied seasonally over spans of hundreds if not thousands of years. Consequently we have much

more information on the period, and for any given locality or region, there is a greater probability that sites which date from the Archaic will be found. This is true of the Piceance Basin and the neighboring regions.

The Piceance Basin would have been ideal for people pursuing an Archaic mode of subsistence. The wide variety of floral and faunal resources would have proven attractive to earlier occupants of northwestern Colorado, and for this reason, as well as those cited above, many Archaic sites can be expected to exist in the region.

The earliest indication of occupation in the Piceance Basin archaeological record comes from 5RB13, a site in the Stake Springs area, about 16 air miles northwest of Tract C-b. A single basal fragment of a parallel-sided, concave-base, unnotched biface that has pronounced polishing on the margins of the blade near the base was found at 5RB13 (C.H. Jennings, 1974). The point is of a class that has been found in various parts of the western United States. The nearest site producing projectile points similar to the one just described is Deluge Shelter in Dinosaur National Monument (Leach, 1967, 1970a). The earliest occupational levels at the site are estimated to date from 7000 B.C. Breternitz (1970) sees this as the initial Archaic occupation in northeastern Utah and northwestern Colorado.

Following the earliest Archaic, the intensity of occupation increased steadily over the next several thousand years. Sites dating from after 5000 B.C. are numerous both south and north of the Piceance Basin (Breternitz, 1970; Buckles, 1971; Day, 1964; Lister, 1951; Wormington and Lister, 1956). Sites of this antiquity have also been found in various parts of the Piceance Basin, and there is some indication of the utilization of Tract C-b during this and later periods.

The Archaic Period has been extended to A.D. 1776, as there is no evidence of the pursuit of any other life style in the Piceance Basin before the first written documentation of the region's inhabitants.

In the neighboring regions a mixed horticultural and foraging subsistence system was followed in prehistoric times. This system and its associated culture items have been gathered under the title of Fremont culture. The Fremont life style was practiced in Utah and northwestern Colorado at least between A.D. 900 and 1200 but may have appeared as early as A.D. 700 (Aikens, 1970:26-30, 192-194, 202-204; Breternitz, 1970:160-161; Gunnerson, 1969; Wormington, 1955). These people cultivated maize, lived in shallow semi-subterranean houses, and produced a characteristic gray pottery which varied in its surface treatment and temper over the area occupied by the people. People of the Fremont also built stone or adobe granaries for the storage of their crops and decorated the walls of the canyons in their territory with anthropomorphic figures. They also, of course, produced implements necessary for the hunting and gathering that supplemented their horticultural production.

Most of the above-summarized attributes are not as yet evident in the Piceance Basin. Of the portable items, only pottery may be represented. A few shards of a gray ware, which is similar in some respects to Fremont pottery but differs in temper, have been recovered from a few sites in the western and northern portions of the basin but none have been found on or near Tract C-b. There is no evidence of Fremont rock art or architecture. The projectile points which have been found in Fremont sites in Dinosaur National Monument have morphological counterparts in the projectiles found on sites in the Piceance Basin. However, there is little that can be said about the potential significance of the similarities because of the stringent physical constraints that exist for lithic technology. The natural or physical limitations on the variety that can be produced in any inventory of stone tools makes the reliable identification of cultural affiliation of most styles of projectile points impossible.

In the light of the ambiguities and gaps in the archaeological record concerning people of the Fremont in the Piceance Basin, it seems advisable to argue that there was no permanent occupation of the basin

during the time they were present in nearby areas such as Douglas Creek (Wenger, 1956). The Fremont people may well have come into the region in search of game and wild vegetable products, but their presence there would not be separable from that of any other contemporaneous group using the region for the same purpose. Consequently, the Fremont exploitation of the Piceance Basin, if any, is classed as a part of the Archaic Period.

The failure of the Fremont to exploit the region at a horticultural level can most reasonably be attributed to the same causes which have limited agricultural activity in the basin in modern times. The cool to cold soils and short growing season are no doubt the principal restrictive factors. Because of the climate, corn cultivation would have been a highly unreliable source of subsistence.

The pursuit of the generalized hunting and gathering pattern, then, is seen as extending to the time that the first written records were made concerning the people of the Piceance Basin and its neighboring regions. No change occurred in A.D. 1776 insofar as the aboriginal inhabitants of the region are concerned; they were simply identified by Europeans in such a way that we can associate them with the ethnographically known groups inhabiting the region in later times.

PROTOHISTORIC PERIOD: A.D. 1776 - A.D. 1868

In 1776 the Spanish priest Escalante crossed western Colorado on his attempted journey to California. In his trek he encountered bands of Indians whom he identified as Yutas (Bolton, 1950:52-55, 163-167). Escalante did not pass directly through the Piceance Basin. His route took him over the Roan Plateau and down Douglas Creek, west of the basin, to the White River. Though Escalante did not actually encounter Indians on Douglas Creek or on the White River, he had been told that a band related to the Yutas he had encountered farther south did inhabit the region.

The Escalante-Dominguez expedition gives the first evidence of the use of the region surrounding Tract C-b by an enthnographically known group, the Utes. Escalante, however, gives us no information on the way of life of the northern Utes.

In the Piceance Basin several sites have been located which may be the remains of the Ute occupation of the region. These sites, such as 5RB53 (near the confluence of Duck and Yellow creeks), 5RB129 (near the confluence of Big Duck and Little Duck creeks), and 5RB144 (in Black Sulphur Gulch), have produced preindustrial artifactual material but no metal or other goods which would indicate contact with Euro-Americans. These sites also have standing remains of structures, or wickiups, which provided necessary shelter. Two of the sites listed above have also yielded a few shards of plain gray pottery. These sites can be hypothetically assigned to the Protohistoric Ute culture in the light of their material contents. Of course, this hypothesis needs to be tested by means of excavation at the sites to obtain a more complete, and probably more representative, inventory of their material culture.

On Tract C-b we found no evidence of the sites described above. The sites located on and near the tract are either definitely tied to the Euro-American occupation of the area or have no clear ethnographic relationships.

EURO-AMERICAN PERIOD: A.D. 1868 - PRESENT

The first White River Ute Agency was established near the present town of Meeker, Colorado, in 1868. The agency was run in the usual fashion of the late nineteenth century in that there was relatively little interference with Indian daily life so long as the Indians made no difficulty for the Euro-Americans moving into the region.

In 1878 the White River Agency was placed under the direction of Nathan C. Meeker who, through ignorance and well-intentioned paternalistic

blundering, created an extremely volatile situation with the Utes residing in his area of responsibility (Brown, 1972:349-367; Emmitt, 1954; Hafen, 1933:199-204, 209-213; Sprague, 1958). The result of the situation was the massacre of the agency's male personnel and the death of several members of a military expeditionary force which Meeker had called for to assist him in meeting the crisis (Brown, 1972:360-366; Hafen, 1933:209-212; Sprague, 1958).

The White River band was removed from the Meeker district following the 1879 uprising. They were placed on a reservation with the Uinta band and access to their ancestral lands was denied them. However, living occupants of the White River region and the Piceance Basin have told the author that the Utes continued to hunt and gather in the area in the 1890s and early 1900s.

The expulsion of the Utes from the Piceance Basin and surrounding areas precipitated a land rush in the early 1880s, which in turn led to the formation of Garfield County and later Rio Blanco County (Hafen, 1933:226). Homesteading in the Piceance Basin was limited primarily to the areas along the major drainages which had either surface water flow or easily accessible groundwater. The homesteading activity led to the founding of a local school district and the construction of a number of school buildings in various parts of the basin. Perhaps the best known of these is the Rock School, which was built in 1897 and subsequently modified by various remodelings and additions. The Rock School is of interest because of the use of oil shale for masonry material.

During the early part of the twentieth century the fortunes of the homesteaders in the Piceance rose and fell, but the end of the homesteading era came with the economic collapse of the 1930s. Many of the homesteads were abandoned, while others, with perhaps more economic potential, were purchased by the more successful ranchers in the region and were incorporated into land and cattle operations. These operations, some of which are still active, were dependent upon the combination of access to extensive tracts or unimproved range through

the various federal leasing programs and on the supplementation of range feed with hay grown in the privately owned irrigable meadows along the better drainages. These practices continue to the present time.

There has also been a long-term interest in the fuel potential of the oil shale deposits in the region. There is an abandoned mine and retort on Piceance Creek Road about 2.5 miles northwest of Rio Blanco. This mine was operated in the 1920s, but apparently with little success. The potential of an oil shale boom was raised in the 1950s, and the federal government, through the Bureau of Mines, opened a mine and experimental retort at Anvil Points during this time.

On Tract C-b there is little evidence that can be definitely assigned to the Euro-American period. The abandoned cabin, 5RB67, is the only unoccupied Euro-American site in the immediate vicinity of the tract. There was no indication that the Utes penetrated as far as Tract C-b in their postexpulsion forays. The occupied ranches have not been investigated. The fact that they are outside the area of study of this project and that they are still in use has placed them on a very low priority insofar as this study is concerned.

SUMMARY

The Piceance Basin has been the scene of human activity since about 7000 B.C. at the very earliest. Between this early date and A.D. 1879 the area was utilized by various groups of American Indians, who hunted the game of the region and gathered the fruits of its varied flora. None of the groups occupying the region at this time left any indication that they attempted any sort of farming. The last occupants of the region were the Ute Indians, who were in the area at least as early as 1776 and who remained there until forcibly removed in 1879.

Upon the expulsion of the Utes from the Piceance Basin, Euro-American settlers began to occupy the area. The early settlers raised sheep

and cattle in the basin, and the subsequent overgrazing had considerable effect on the landscape. Interest in the minerals underlying the basin has fluctuated during the twentieth century but has never led to any extensive exploitation plans until the present time.

The role that Tract C-b played in the cultural history of the region is not entirely clear. Prior to the discovery of the sites described in Section V there was no evidence that the tract area played any role in the regional history whatsoever. What is clear is that the aboriginal occupants of the Piceance Basin did include the tract vicinity in the territory they saw fit to occupy and exploit. The length of time and the nature of that exploitation and occupation are also discussed in Section V.

V

CULTURAL RESOURCES

PREHISTORIC SITES

Four prehistoric archaeological sites have been recorded on Tract C-b and in immediately adjacent areas. The tract itself has been intensively examined for antiquities, but in the adjacent areas site discovery has been the result of chance encounters rather than any systematic survey. Considerable caution must be used in any attempt to extrapolate the nature of the cultural resources of the surroundings from what is known of the resources of the tract proper.

5RB69

Location. T2S, R97W, NW¼NW¼ Sec. 36; north of the tract boundary and about 300 meters east-southeast of the confluence of Willow Creek and Piceance Creek (Figure 3). It is about 250 meters northwest of the nearest approach of the main access road to the tract from Piceance Creek Road.

Topographic Situation. The site is on the northern edge of what appears to be an alluvial terrace (Figure 2) on the south side of the Piceance Creek Valley. It is about 27 meters above the flood plain of Piceance Creek. The site is principally north-facing, but it is also exposed to the east and west because of its relatively distant position from the bluffs which form the southern side of the valley.

Features. No evidence, either direct or indirect, was found to indicate the presence of any stationary objects such as fire pits, house floors, or storage structures.

Figure 3. VIEW OF THE 5RB69 LOCALITY FROM ABOUT 1 KILOMETER UPSTREAM OF PICEANCE CREEK (Arrows indicate site position on terrace rim.)

Condition. The surface and immediately underlying materials have been disturbed to a depth of about 5 centimeters by livestock walking over the site when the soil was wet. The area has been used as a feeding and watering station for cattle in the recent past. There is also a good possibility that the local residents have collected at least some of the artifactual material from the surface. There was no sign of uncontrolled excavation.

Artifacts. Six flakes comprise the total artifactual yield of the site. Two water-worn cobbles, originally thought to be milling stones, were found on the site, but laboratory study indicates that there is no alteration of either cobble from its natural configuration.

Cultural Affinities and Dating. The artifactual yield is too limited to permit any assignment of the site to a time period other than to say that it is Protohistoric or earlier. Culturally, the site can only be said to relate to the Native American occupation of the locality.

Evaluation and Recommendations. This site has been disturbed by modern uses. It lacks any evidence of having been utilized intensively. We can safely say that 5RB69 has neither scientific value nor historic or cultural significance. It is recommended that no further action be taken to protect or conserve this site.

5RB136

Location. T3S, R96W, NE¼SW¼ Sec. 5; northeastern corner of the tract (Figure 2). The site is located about 1400 meters southwest of the confluence of Stewart Gulch and Piceance Creek, and about 1800 meters southeast of the confluence of Sorghum Gulch and Piceance Creek. The locality is approximately 230 meters north of core hole Cb-3 and 1300 meters south-southwest of the Walter Oldland Ranch.

Topographic Situation. 5RB136 is on the crest of the ridge between Stewart Gulch and Sorghum Gulch and slightly down the eastern side of the ridge. The site is on fairly level ground, though there are very slight downslopes to the north and the east. Though the locality is elevated well above the immediately surrounding terrain, it does not have a good view of any of the surrounding lowlands because of the dense stand of pinyons and junipers on the ridge. The site is topographically exposed to the north, south, and east, but the dense tree cover gives it excellent protection from the wind.

Features. There are no visible features present on the site. However, a few fragments of shattered bone were found which had been exposed to intense heating. Burned bone fragments such as these are frequently found in the fire pits over which preindustrial man cooked his food. It is assumed that such features could be present at 5RB136 and that any disturbance of the immediate surface would expose them.

Condition. The site is relatively undisturbed. The truck trail which climbs up from Sorghum Gulch and travels along the ridge crest cuts across the western edge of the site. There is also a dump of modern trash on the southern end of the site. There is no evidence of disturbance of the deposits, and the condition of the site is deemed good.

Artifacts. The artifact yield at 5RB136 was relatively small. Only seven waste flakes were found, indicating that relatively little stone tool manufacture or repair was done there. A single tool (Figure 4*a*) was found at the southeastern extremity of the site. It is a bifacially flaked object with no modifications, such as notches, of the blade margins. The blade sides are straight, at least from the base to the point at which the tip was broken off, and the overall form of the object was probably lanceolate. The base shows no signs of grinding and there is only a very slight concavity to the basal margin.

Review of some of the pertinent literature indicates that similar

Figure 4. SMALL CHIPPED STONE ARTIFACTS FROM TRACT C-b

a	5RB136.1	*e*	IF112
b	5RB146.1	*f*	IF113
c	5RB146.3	*g*	IF110
d	IF109	*h*	IF111

objects have been found in relatively few places. Reasonably close similarities exist between this specimen and types W1 and W42 from Danger Cave (J.D. Jennings, 1957:101, 132). There is also a similar type from Caldwell Village (Ambler, 1966:40, Figure 41*b*), a Fremont site near Vernal, Utah. The precise degree of relationship with these other examples cannot be established, but it is clear that the Danger Cave types represent a span of several thousand years (J.D. Jennings, 1957:93, Figure 38) and the Caldwell Village type only the time period between A.D. 1050 and 1200 (Ambler, 1966:66).

Cultural Affinities and Dating. The absence of diagnostic artifacts from the 5RB136 inventory makes determination of the age of the occupation or the cultural affinities of the occupants impossible. From the comparison with other sites where similar artifacts have been found, it should be clear that the age of the site could range anywhere from several thousand years to only a few hundred. Any more definite assignment will have to await more intensive study of the site.

Evaluation and Recommendations. The potential of 5RB136 in terms of helping to clarify the timing and cultural relations of the earlier human occupations of the Piceance Basin is not clear. The site may have considerable value if the hypothesized fire pits are in fact present. We would expect to find more cultural material and should also be able to recover materials suitable for radiocarbon dating. This information would be of considerable scientific value.

The cultural and historical significance of the site is another matter. Sites of this sort seem to be numerous in the region and 5RB136 is by no means the best example of the class. Consequently, we would not recommend this site for nomination to the National Register of Historic Sites.

5RB146

Location. T3S, R96W, SE¼SW¼ Sec. 5 with some overlap into the NE¼NW¼

Sec. 8 (Figure 2). The site is located within 50 meters of the quarter-section marker on the boundary between Sections 5 and 8. The site is approximately 730 meters west-southwest of the confluence of Stewart Gulch and its West Fork and about 320 meters south of core hole Cb-3.

Topographic Situation. 5RB146 occupies about the same topographic position as 5RB136. The principal exception is that there is a tributary drainage to Stewart Gulch which has incised itself into the eastern flank of the ridge. The result is somewhat greater exposure to the east than 5RB136 has. Also, there is a small knoll, on which the quarter-section marker is located, to the south of the site. This small elevation gives 5RB146 somewhat more shelter from the south than 5RB136 has.

Features. No features were noted at 5RB146 and there was no evidence which implied the presence of stationary objects.

Condition. The chaining of the ridge tops described in the discussion of the tract vegetation has included the area of 5RB146. The site has been extensively disturbed, except for the pinyon-juniper copse left standing around the quarter-section monument. The truck trail which passes 5RB136 also passes 5RB146 on the western side of the site. There may have been some disturbance of the site by the trail as well as by the chaining. In general, outside the protected area near the monument the site is in very poor condition and its scientific and cultural values have been destroyed.

Artifacts. As with its near neighbor, 5RB146 has a relatively limited artifact inventory. Only three waste flakes could be found in the area, indicating rather limited use of the site.

Two projectile points (Figures 4*b* and *c*) were found at 5RB146. The first (catalog no. 5RB146.1) is a triangular-bladed diagonally notched specimen. The blade margins are straight and very lightly serrated. The notches are wide and deep, producing an expanding stem. The basal

margin is slightly concave. The tip, one tang, and both barbs are broken. The point is generally comparable with type W18 from Danger Cave (J.D. Jennings, 1957:115) and with some points from levels 2 and 3 of the Taylor site (Wormington and Lister, 1956:Figures 40, 41), a site on the Uncompahgre Pleateau near Whitewater, Colorado. At Danger Cave, the style dates from about 7010 B.C. to 1869 B.C. (J.D. Jennings, 1957:93 and Figure 38). No dates are assigned to the Taylor site materials.

The other projectile point (catalog no. 5RB146.3) is more difficult to find in the relevant literature. The specimen is triangular but slightly assymetrical: one blade margin is straight while the other is convex. Both edges of the blade are lightly serrated. The stem is broken off but the barbs remain, indicating that the point had deep narrow notches which formed an acute angle between the long axes of the notches and the long axis of the blade. Comparison with the projectile points recovered from other sites in the neighboring regions revealed only one similar specimen. This came from the Moore and Casebier sites on the Uncompahgre Pleateau near Delta, Colorado (Wormington and Lister, 1956: Figure 8*a*). No dates were assigned to this type at the Moore and Casebier sites.

Finally, a single scraper fragment (catalog no. 5RB146.2) was also found at the site. The tool was made of a flake of jasper which still has cortical material remaining on the edge opposite the working edge. The retouched margin forms an acute angle and the remaining portion is less than 1 centimeter long.

<u>Cultural Affinities and Dating</u>. There is no evidence from 5RB146 which indicates what the cultural ties of its inhabitants may have been. The dating of the W18 types at Danger Cave indicates that the site may have been occupied relatively early in the basin's prehistory. However, Danger Cave is several hundred miles west of the Piceance Basin, near Wendover, Utah. Even if several centuries of difference in time of occurrence are allowed between the two sites, the implication that

5RB146 was occupied before the beginning of the Christian era is quite clear. The site is thus assigned to the Archaic Period and probably falls near the middle of the period.

Evaluation and Recommendations. The sparse artifactual yield of 5RB146 is indicative of limited use of the site and implies that it has a low potential value either as a source of information that will help to fill in the frail outline of Piceance Basin prehistory or as an example of the kind of settlement occupied during the middle portion of the Archaic Period. Consequently we recommend that no further action be taken regarding this site unless it is to be endangered by development. If the portion of the site which is within the undisturbed area around the quarter-section marker is to be altered in any way, we recommend that limited testing be carried out to verify the assumptions made here. The site warrants, as nearly as can be estimated from the surface collections, neither nomination to the National Register nor intensive excavation.

5RB147

Location. T3S, R97W, SE¼SE¼ Sec. 2; near the northwestern corner of the tract (Figure 2). The spot is about 640 meters south-southeast of the confluence of Willow Creek and Scandard Gulch on the ridge dividing the two drainages.

Topographic Situation. The site is in a ridge-top situation similar to that of 5RB136 and 5RB146, but in this case the ridge is considerably greater. The site is also southeast of a sizable sandstone outcrop which rises 3 or 4 meters above the site. The site has a good view of Scandard Gulch and the tract area to the east. The eastern exposure is ideal in that it permits the area to receive direct sunlight early in the day and yet it is protected from the prevailing winds from the north and the west.

Features. No stationary cultural objects were observed at 5RB147, nor was there any other evidence to indicate that fire pits, house floors,

or storage structures would be present but not observable.

Condition. Because this area has been subjected to chaining, much of the site has been extensively disturbed. The cultural material collected from the site was concentrated near the base of the sandstone outcrop sheltering the site, an area which showed less disturbance than other parts of the potential area of occupation. Generally, the site has been subjected to considerable disturbance and is considered to have been destroyed.

Artifacts. The site produced four waste flakes and a small fragment of the blade of a knife or projectile point (catalog no. 5RB147.1). The tool is far too fragmentary to be compared with materials from other sites.

Cultural Affinities and Dating. The lack of diagnostic cultural material precludes either the determination of the cultural ties of the former occupants of the site or the time of that occupation. The site has been included with the prehistoric sites because of the lack of items which would identify it with the Protohistoric Period.

Evaluation and Recommendations. This site is of no scientific value and has no historical significance. The site should receive no further attention and should not be nominated to the National Register.

EURO-AMERICAN SITES

5RB67

Location. T3S, R96W, NW¼NE¼ Sec. 21; the site is just outside the southeastern extremity of the tract (Figure 2). The location is about 900 meters upstream from core hole SG-14, on the Middle Fork of Stewart Gulch, and about 2.2 kilometers from the Middle Fork and East Fork confluence.

Topographic Situation. The site is located on an alluvial fan spreading

across the bottom of the Middle Fork canyon from a tributary which flows in from the east. The location is on the eastern side of the canyon, about midway between the arroyo cutting the canyon floor and the sandstone cliffs which form the eastern canyon wall. The site is exposed to the north, south, and west.

Features. The site consists of a cement-chinked log cabin, a dugout, and a thin scatter of historic trash. An abandoned irrigation ditch also crosses the site.

Condition. The cabin has not been in use for many years and is in a bad state of repair. All the windows are broken, the door is missing, and the roof is showing signs that it will soon collapse. The roof of the dugout has already partially collapsed. The site can be said to be in poor condition, though there are no signs of disturbance of the deposits which might contain evidence of earlier historic occupation.

Artifacts. Materials collected from the site include a number of beer cans dating from the late 1940s and early 1950s, as well as pottery and glass shards. No other material of significance was noted or collected.

Cultural Affinities and Dating. The site is obviously of Euro-American origin. The last significant use of the site, as indicated by the beer cans, must have been about 25 years ago. The time of the earliest occupation has not yet been established. Archival research is not yet complete for the historic sites, but it seems likely, judging from the round-headed wire nails used in the construction of the cabin, that the site was built after the turn of the centry and perhaps no earlier than the 1920s.

Evaluation and Recommendations. The site has no apparent potential for nomination to the National Register and no action to do so will be taken. There are numerous such sites scattered over the region and many of them are in better condition and have longer periods of occupation than 5RB67. No further action need to be taken to protect or conserve this site.

ISOLATED FINDS

Projectile Points

Three projectile points that were collected from the tract area could not be associated with any other artifactual materials. These artifacts, as with the other isolated finds, were probably lost or discarded at the places where discovered. The scattering of isolated artifacts over a large area is consistent with our findings from other parts of the Piceance Basin (C.H. Jennings, 1974).

Isolated Find 109. This projectile point (Figure 4*d*) was found just off the main tract road in T3S, R96W, NW¼SE¼ Sec. 17 on a small bench extending into the West Fork of Stewart Gulch.

The point is nearly complete, missing only its tip, and shows well-controlled pressure flaking. The blade is triangular and has slightly convex margins. The notches are diagonal and are about as wide as they are deep. The base is convex and the stem is slightly expanded.

The most similar previously recorded type is the Rose Spring Corner-Notched, such as those found by Aikens (1970:35) at Hogup Cave in northwestern Utah. Similar points have also been found at the Taylor site in levels 2 and 3 (Wormington and Lister, 1956:Figures 40, 41), at Danger Cave in the most recent deposits (J.D. Jennings, 1957:93, 129, Figure 38), at various Fremont sites in Dinosaur National Monument (Breternitz, 1970:5, 18, 53, 64), and in other sites in the Monument where the type is found in the later Fremont levels of multicomponent occupational series (Jennings and Wade, 1970:88; Lister, 1951:15, 38-41). In all the above-noted cases the indications are that the point type described here appears after the beginning of the Christian era but probably sometime before A.D. 1000.

Isolated Find 112. This is a broad though still triangular-bladed point with slightly convex margins (Figure 4*e*). It is diagonally notched,

but the notches are more nearly perpendicular to the long axis of the blade than in the case of IF109. The stem is expanded and the base convex. The specimen is nearly complete, with only the extreme portion of the tip missing. This point was found in T3S, R96W, NW¼SE¼ Sec. 7.

Comparison with other areas indicates that this point type is widely distributed. The type appears in preceramic, or pre-Fremont, contexts in several sites in Dinosaur National Monument (Breternitz, 1970:5; C.H. Jennings and Wade, 1970:87-88; Leach, 1970b:129-130). The Elko Corner-Notched points from Hogup Cave (Aikens, 1970:35, Tables 2 and 4, Figure 24) are identical to IF112 and date approximately between 1250 B.C. and A.D. 1330. The extreme dates given above should be regarded as those which will certainly include the span of popularity of the type and may represent a considerably longer period than the type was actually in vogue. The type has also been found in the less tightly dated contexts of the Taylor site (Wormington and Lister, 1956:Figure 41) and Danger Cave (J.D. Jennings, 1956:118).

Isolated Find 113. This point (Figure 4*f*) was found in T3S, R96W, NW¼-SE¼ Sec. 18 on the rim of a bench overlooking Sorghum Gulch from the east. The tool is triangular-bladed with straight margins. The notches have been made in the sides rather than the corners of the point, but they differ from one another in size and orientation to the long axis of the blade, making the point assymetrical in silhouette. Also, the angles formed between the blade margins and the central axis are not equal, further enhancing the assymmetry. The base is sinuous in form because of the removal of several rather large thinning flakes from the base. The flaking is generally not well controlled, which may be because of the nature of the material, quartzite, rather than the lack of skill of the maker.

Comparison with other areas follows much the same pattern of distribution as was the case for IF109 and IF112. Similar points have been found in Dinosaur National Monument (Breternitz, 1970:5, 19, Figure 141),

in the Wendover, Utah, area (Aikens, 1970:36; J.D. Jennings, 1957:119), and on the Uncompahgre Plateau (Wormington and Lister, 1956:Figure 41). In all cases the chronological context appears to be the same as that for IF112. At Hogup Cave, though, the Elko Side-Notched points, to which IF113 is analogous, reach their peak of popularity earlier than do the Elko Corner-Notched points (Aikens, 1970:Figure 24, Table 4). The radiocarbon dating from Hogup Cave for this type indicates an age between the fifth and fourth millenniums B.C. Consequently IF113 may indicate a somewhat earlier use of Tract C-b than does IF112.

Other Chipped Stone Tools

Isolated Find 110. This is a simple flake which has been retouched for a short distance along one margin on both faces (Figure 4*g*). It most likely served as a knife rather than a scraper. This assumption is based on the bifacial retouch and the acute angle formed by the two retouched faces at the working edge. The object was found in T3S, R97W, Sec. 25 (1/16th section information was not recorded for this specimen, which was found while examining the alignment of a core-hole access road). This kind of object is quite common in prehistoric sites from all time periods and in many parts of the world; the diagnostic value is nil.

Isolated Find 111. This tool (Figure 4*h*) is of interest not because of its diagnostic value but because tools of this kind are relatively rare in the Piceance Basin. The tool is a combination form. It has an acutely retouched working edge along one of its longer edges and a very steeply retouched working edge on one of the shorter edges. The more steeply retouched surface is on the distal end of the flake and has been worked into a finely but unifacially retouched point where the distal and the generally unretouched lateral margins meet. The retouch is all on the dorsal face of the flake, and there is obvious evidence of polishing at the retouched point on the ventral surface of the flake.

The conclusion is that the tool is a combination side and end scraper which also had an intentionally produced graver tip. Similar tools have been found at Swelter Shelter in Dinosaur National Monument in the pre-Fremont levels (Leach, 1970:131). The tool was found in T3S, R97W, SE¼NE¼ Sec. 2.

Isolated Find 114. This specimen (Figure 5*a*) is a core from which the flakes for manufacture into tools were removed. It was found in T3S, R97W, SE¼SE¼ Sec. 2. The object is a water-worn quartzite cobble of about double-fist size. There are three flake scars on one of the altered surfaces and two scars on the other. The sharp edge formed where the scars meet shows no evidence of wear, which would indicate that the specimen served some other function than as a core. The object is not suitable for dating.

Isolated Find 117. This is a very small fragment of a bifacially chipped tool. It was found in T2S, R96W, SE¼SE¼ Sec. 31 on a point overlooking the Piceance Creek flood plain from the north side of the valley. The find was made by Mr. Don Tait of the Atlantic Richfield Company and turned in for analysis. Unfortunately, the specimen is too small to identify, but it does indicate that there are probably sites on the north side of Piceance Creek as well as on the south.

Ground Stone Tools

Isolated Find 115. IF115 is a subrectangular mano, or hand stone, which was used in the processing of nuts and seeds into meal (Figure 5*b*). Such objects are found in Archaic and later sites in all parts of the deserts of the West, and they have little value as either temporal or cultural diagnostics.

This specimen was intentionally prepared in that the nonworking faces or edges were also pecked and ground until the desired shape was reached. The mano has two working faces, the top and bottom faces, both

Figure 5. CORE AND HAND STONES FROM TRACT C-b

a IF114
b IF115
c IF116
d IF118

of which show considerable polish and which have been lightly pecked to increase their abrasive qualities. The tool is made of a quartzite cobble and is about the right size for one-handed use.

The tool was found in T3S, R97W, NW¼SE¼ Sec. 11. To find a hand stone without any other artifactual material seems unusual in the light of our other work in the region. In other parts of the basin we rarely found ground stone tools out of association with sites. Careful examination of the general area from which the mano came produced no other artifactual material, and the isolation of the mano must be accepted.

Isolated Find 116. This is another mano (Figure 5*c*) and differs from IF115 in that it has only one working face and is longer in proportion to its width. All of the considerations noted above apply to this specimen as well. It was found in T3S, R96W, NW¼SW¼ Sec. 19.

Isolated Find 118. IF118 (Figure 5*d*) was recovered by Dr. Warren Keammerer in T3S, R96W, NW¼SW¼ Sec. 5. The specimen may be associated with 5RB146, but precise information on the location at which the find was made was not available at the time of this writing.

The specimen is a small water-worn cobble of some dense, find-grained, black material. It shows no manufacturing or use marks but does have prominent flattened areas or facets on the two faces. It has no other features of note and has no diagnostic value.

SUMMARY AND INTERPRETATION

Tract C-b and its immediately adjacent areas have been found to contain a small cultural resource. The resource has manifested itself in the form of four prehistoric sites (three within the tract and one outside), a historic site outside the tract boundary, and several isolated artifacts found scattered over the area.

All sites are small and their artifactual yields indicate ephemeral

occupation. Two sites, however, may have some potential for improving our present understanding of man's use of the area and should be investigated further in the event they are to be endangered by future development. The others are seen as having no potential for improving our knowledge and none of the sites are deemed worthy of nomination to the National Register.

The time period represented by the sites and the isolated artifacts falls roughly between about 5000 B.C. (by radiocarbon dating) and the early 1950s. This spans the Archaic and Euro-American periods outlined in the discussion of the region's cultures. The evidence from the sites indicates that in the vicinity of Tract C-b there was no deviation from the life styles described in Section IV. The area was used first by hunter/gatherers and later by pastoralists who raised sheep and cattle.

From the foregoing we assume that the Tract C-b area was only lightly occupied. Comparison of the tract localities with those of the Stake Springs vicinity or of lower Duck Creek (C.H. Jennings, 1974), indicates that the area was evidently not on the list of preferred camping localities during prehistory. The reasons for this expression of preference are not yet clear. As indicated in the discussion of the tract's natural resources, the locality is well endowed and a paucity of subsistence resources cannot explain the low density of occupation. Further analysis of the settlement patterns in the more heavily utilized parts of the basin is necessary before we can go further toward trying to find an explanation.

Another route may also need to be investigated with respect to the low site density on Tract C-b. The chaining of the pinyon-juniper in this locality can only have had deleterious effects on the rather fragile archaeological sites. It may be that much of the evidence of prehistoric activity was destroyed by the range improvement program, which was undertaken without making any sort of cultural resource inventory. If no other reasonable explanation appears, this latter possibility may have to be recognized.

In conclusion, it is possible to say that there is no factor in the cultural resource inventory to prevent further development of the mineral resources on Tract C-b. There are some provisos to this, however, and they are discussed below.

RECOMMENDATIONS

Specific recommendations for each of the recorded sites have already been made. In summary, 5RB136 and 5RB146 are the only sites deemed worthy of future consideration in the development of Tract C-b. These two sites should be provided some protection during the development of other areas on the tract. This protection would best take the form of posting to warn off relic collectors and others who might endanger the sites. In the event that some development activity must take place near the sites (within approximately 100 meters), the sites should be test-excavated to verify the conclusions concerning their scientific value and to preserve some of their content for future generations.

The other recorded sites in and near the tract will require no further study. These sites either have very little potential or have already been destroyed by human or natural actions.

Note should be made here that there has been no systematic examination of the areas immediately adjacent to the tract. The sites recorded outside the tract and described here were found by accident rather than by design. Consequently there is no reliable way of estimating the potential value of any cultural resources that might be present there. Judging from the information collected for the tract proper, it seems likely that there will be archaeological sites adjacent to Tract C-b. It is therefore recommended that in the event that development of Tract C-b is imminent, investigation of the areas adjacent to Tract C-b, to a distance of about 1 kilometer, be subjected to systematic reconnaissance to determine the nature and extent of the cultural

resources in the vicinity of the tract. The responsibility for this extension of the archaeological study lies with the tract developers. While it is obvious that the physical development of the oil shale mining operations will not extend beyond the borders of the tract, there is a great potential for a secondary impact on the cultural resources in the adjacent areas. This secondary impact will come from the attraction of greater numbers of people to the tract area. Since the areas surrounding the tract will be subjected to greater recreational use than at the present, the potential exists for endangering sites that have not yet been discovered. Also, once an area is opened, larger numbers of relic collectors will have access to the sites in the locality. If the cultural resources in the vicinity of Tract C-b are to be conserved, it is necessary to obtain an estimate of what is present before any further damage occurs.

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Appendix A

SITE INVENTORY FORMS

ARCHAEOLOGICAL SURVEY OF COLORADO
INVENTORY SHEET

Site No 5RB67 , Rio Blanco County, Colorado State White River-Piceance Creek-Stewart Gulch Drainage

1· Prior No·/Name PB 73-96 Used By CSU Regional Oil Shale Study

2· Elevation 2024 m. 3· Jessup Gulch 7½ min USGS Quad 4 Other Map

5· **LOCATION** On the east side of Middle Fork of Stewart Gulch at the base of the eastern wall of the shallow canyon. The site is about 30 m. so. of prominent tributary. U·T·M· Grid 4,407,120 N. 742,130 E.
, NW¼, NE¼ of SEC· 21 TOWNSHIP 3S , RANGE 96W

6· Owner 7· Address

8· Tenant 9· Prior Owner(s)

10· Informant None 11· Address N/A

12· **NEAREST WATER** Middle Fork, Stewart Gulch permanent , season XXXX

13· Distance to 12 91 m. 14· Elevation of 12 2017 m.

15· **LOCALE VEGETATION** Rabbit brush, Sage, Grasses, Pinyon, Juniper

16· **SITE TYPE** Hist. Archit. 17· Cultural Affiliation (if known) Euro-american

18· Description The site consists of a single room cabin and a collapsed dug-out about 20 m. east of the road up the Middle Fork. The structures are on the southern edge of an alluvial fan spreading from a seasonal tributary of the Middle Fork. There is a thin scatter of historic trash and an abandoned irrigation ditch also on the site. A corral is located about 50 m. north of the site.

19· Size 50 m. in diam. 20· Faces to (cardinal direction) Northwest

21· Depth & Character of Deposits Alluvial gravel and fines with fines in the preponderant majority. As indicated above the deposits are transported materials whose source is apparently the ridge to the east of the site. Depth of at least 5 m.

22· Material Observed or Reported Stack of fence poles, 1955 Chevrolet, Pick-up truck tailgate, 2 coil bed spring sets, tin cans, broken window glass, and nails.

23· Material Collected None

24· Condition Roof of cabin is bowed, windows broken, door broken.

25· **RECOMMENDATIONS** None. This site is too recent to be of any value in understanding local history. Also the site has probably been disturbed by hunters who have evidently been using the site as a camp.

26· Photograph Nos· None 27· Recorded By C. Holder, D. Hall

28 Date 7/9/73

SEND TO — Office of the State Archaeologist
5-A Ketchum Hall
University of Colorado
Boulder, Colorado 80302

SEE REVERSE
& CONTINUATION SHEET
Nos·

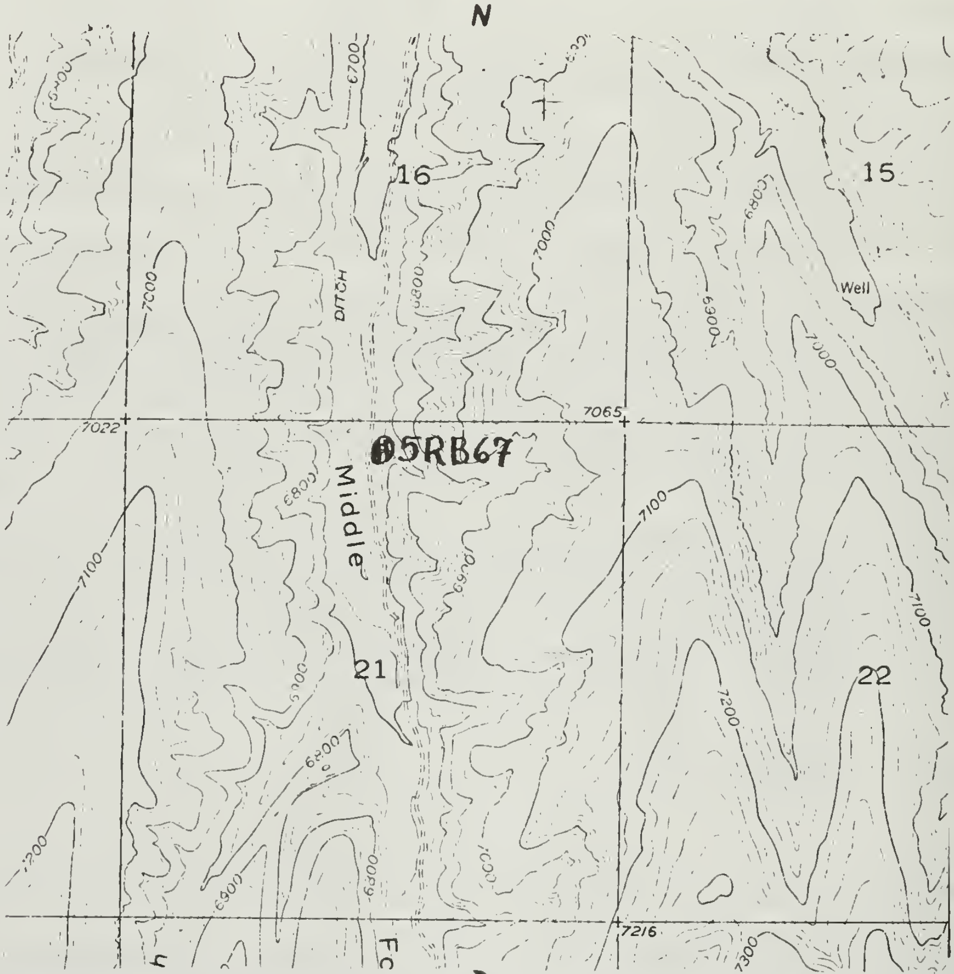
Site No. 5RB67 , Rio Blanco County, Colo. State· Middle Fork Stewart Gulch Drainage· NE¼ SEC 21 , T. 3S , R. 96W · Page 1 of 2

Sketch Map of Location

Site No. 5RB67

NW¼, NE¼ Section 21, Township 3S, Range 96W.

Indicate the chief topographic features, such as streams and elevations. Also indicate houses and roads. Enclose the site area with dotted line. If possible, show extent and kinds of vegetation and sources of other natural resources which may have influenced site selection. Attach a Xerox of portion of U.S.G.S. quadrangle map showing site location, if possible.



SCALE 1 block = 2600' *(if diagram does not equal a section)*

Directions to site: From the intersection of Piceance Creek Road and Colo. Highway 13 and 789 drive northwestward on Piceance Creek Road about 17.4 mi. and turn south (left) on the main Stewart Gulch road. Travel south 2.4 mi., staying to the left at the junction of Stewart Gulch and the West Fork; which is the junction of the East and Middle Fork roads. Here turn right and proceed south along the Middle Fork about 1.6 mi. to the site.

ARCHAEOLOGICAL SURVEY OF COLORADO INVENTORY SHEET

Site No 5RB69 , Rio Blanco County, Colorado State White River-Piceance Creek Drainage

1· Prior No·/Name PB 73-98 Used By CSU Regional Oil Shale Study

2· Elevation 1932 m. 3· Jessup Gulch 7½ min U·S·G·S· Quad 4 Other Map

5· **LOCATION** On terrace rim overlooking Piceance Creek flood plain from the south. The spot is about 350 m. east-southeast of the confluence of Piceance and Willow Creeks and about 40 m. north of the main access road to the Cb Oil Shale lease tract. U·T·M· Grid 4,413,400 N. 736,350 E.
, NW¼, NW¼ of SEC· 36 TOWNSHIP 2S , RANGE 97W

6 Owner 7· Address

8 Tenant 9· Prior Owner(s)

10· Informant None 11· Address N/A

12· **NEAREST WATER** Piceance Creek permanent XXX ,season

13· Distance to 12 75 m. 14· Elevation of 12 1905 m.

15· **LOCALE VEGETATION** Juniper, Sage, Rabbit brush, Grasses

16· **SITE TYPE** Open Chipping 17 Cultural Affiliation (if known)

18· Description Extremely thin scatter of flakes on the rim (northern edge) of the first terrace above the Piceance Creek flood plain. The area is slightly dissected by a minor arroyo flowing northward into Piceance Creek. There has also been considerable disturbance of the surface by cattle but there is no evidence of disturbance of the subsurface deposits by construction or plowing.

19· Size 180 m x 45 m 20· Faces to (cardinal direction) North

21· Depth & Character of Deposits Depth is indeterminate. Deposits consist of gravels and fines with the coarser materials dominant on the face and rim of the terrace and the fines dominant south of the rim. There is no evidence of deeply buried cultural material.

22· Material Observed or Reported See below.

23· Material Collected Flakes, mano. Collection made at random from whole site area. It is likely that all of the cultural material present on the surface of the site at the time of collection was recovered. A re-visit to the site produced no more material.

24· Condition Surface slightly disturbed by livestock. Some erosional dist.

25· **RECOMMENDATIONS** None. This site shows no potential for improving our knowledge of the prehistory of the area.

26· Photograph Nos· 27· Recorded By C.H. Jennings

28 Date 7/10/74

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5-A Ketchum Hall
University of Colorado
Boulder, Colorado 80302

SEE REVERSE & CONTINUATION SHEET Nos·

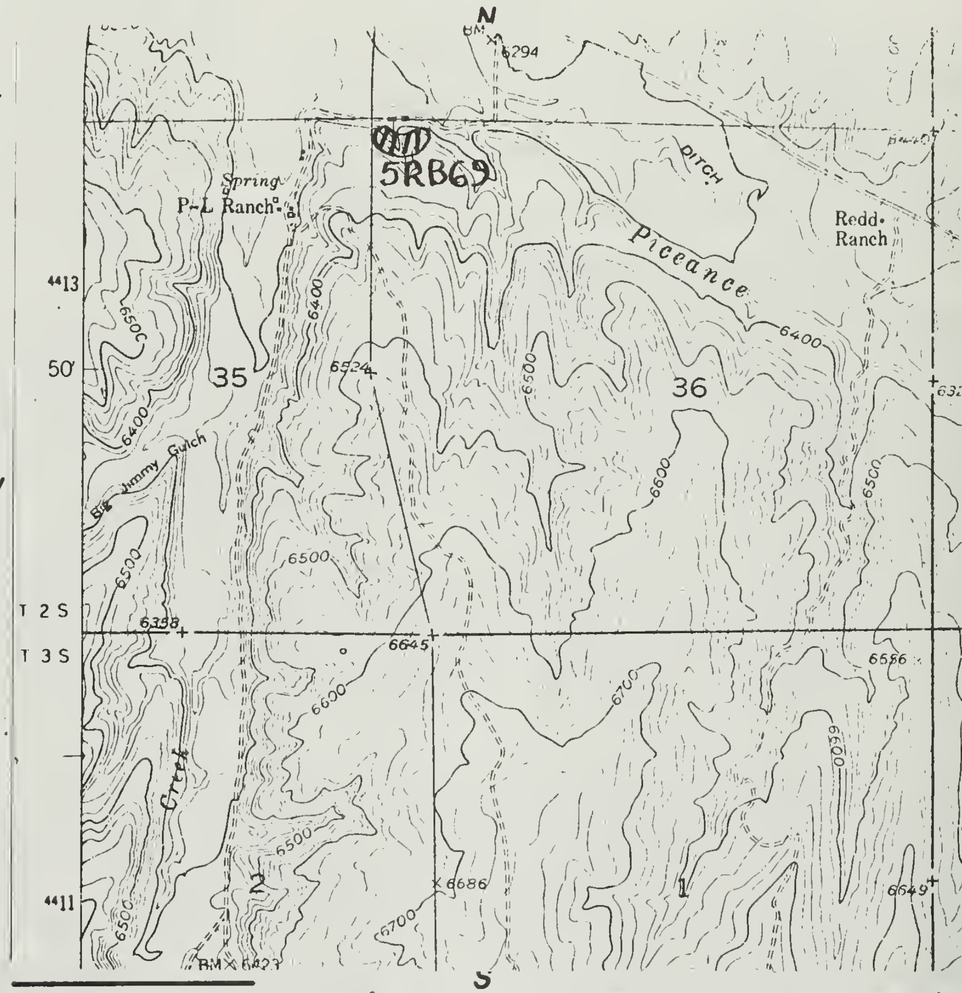
Site No· 5RB69 Rio Blanco County, Colo. State· Piceance Cr. Drainage· NW¼ SEC 6 , T 2S , R 97W · Page 1 of 2

Sketch Map of Location

Site No· 5RB69

NW¼, NW¼ Section 6, Township 2S, Range 97W·

Indicate the chief topographic features, such as streams and elevations· Also indicate houses and roads· Enclose the site area with dotted line· If possible, show extent and kinds of vegetation and sources of other natural resources which may have influenced site selection· Attach a Xerox of portion of U·S·G·S· quadrangle map showing site location, if possible·



SCALE I block = 2600 (if diagram does not equal a section)

Directions to site: Drive northwestward from the junction of Colorado Highway 13 and 789 and Piceance Creek Road along the latter for approximately 20.8 mi. This spot is the junction of the access road to the PL Ranch and Piceance Creek Road. Turn south (left) and cross Piceance Creek.; Stay to the left at the next junction and travel up to the top of the terrace. The site is located north of the road at roughly the point where it turns back to the south after travelling along the terrace in a westerly direction for a distance of about 0.1 mi.

ARCHAEOLOGICAL SURVEY OF COLORADO
INVENTORY SHEET

Site No. 5RB136, Rio Blanco County, Colorado State White River-Piceance Creek-Stewart Culch Drainage

1. Prior No./Name None Used By

2. Elevation 2054 m. 3. Jessup Gulch U.S.G.S. Quad 4. Other Map

5. **LOCATION** Ca. 0.8 mi. SSE of confluence of Collins Gulch and Piceance Creek atop the ridge between Sorghum and Stewart Gulches. Ca. 0.7 SSW of Oldland Ranch. U.T.M. Grid 4,410,950 m N 740,350 m E, NE¼SW¼ of SEC. 5 TOWNSHIP 3S, RANGE 96W

6. Owner Public Domain 7. Address

8. Tenant 9. Prior Owner(s)

10. Informant 11. Address

12. **NEAREST WATER** Stewart Gulch permanent XXXX, season

13. Distance to 12 1320 m. 14. Elevation of 12 1950 m.

15. **LOCALE VEGETATION** Pinyon, juniper, opuntia, Indian Rice Grass

16. **SITE TYPE** Open chipping 17. Cultural Affiliation (if known)

18. Description Sparse scatter of flakes along ridge top in moderately dense pinyon-juniper stand. Truck trail passes west of visible protion of the site. There is a modern trash pile near the southern end of the site.

19. Size 30 m x 10 m 20. Faces to (cardinal direction) East

21. Depth & Character of Deposits Sandy residual from Evacuation Creek s/s. Bed-rock outcrops on eastern edge of site. Quite likely very little depth.

22. Material Observed or Reported Tin cans, broken bottles, scattered flakes, burned bone fragments.

23. Material Collected Flakes, burned bone.

24. Condition Slightly disturbed by truck trail but otherwise evidently in good condition.

25. **RECOMMENDATIONS** Site should be extensively tested and/or systematically surface collected if it is endangered by development. Measures should also be taken to protect it from vandalism but it should not be nominated to the National Register.

26. Photograph Nos. None 27. Recorded By C.H. Jennings, A.P. McNamara

28. Date 7/20/74

SEND TO — Office of the State Archaeologist
5-A Ketchum Hall
University of Colorado
Boulder, Colorado 80302

SEE REVERSE & CONTINUATION SHEET Nos. None

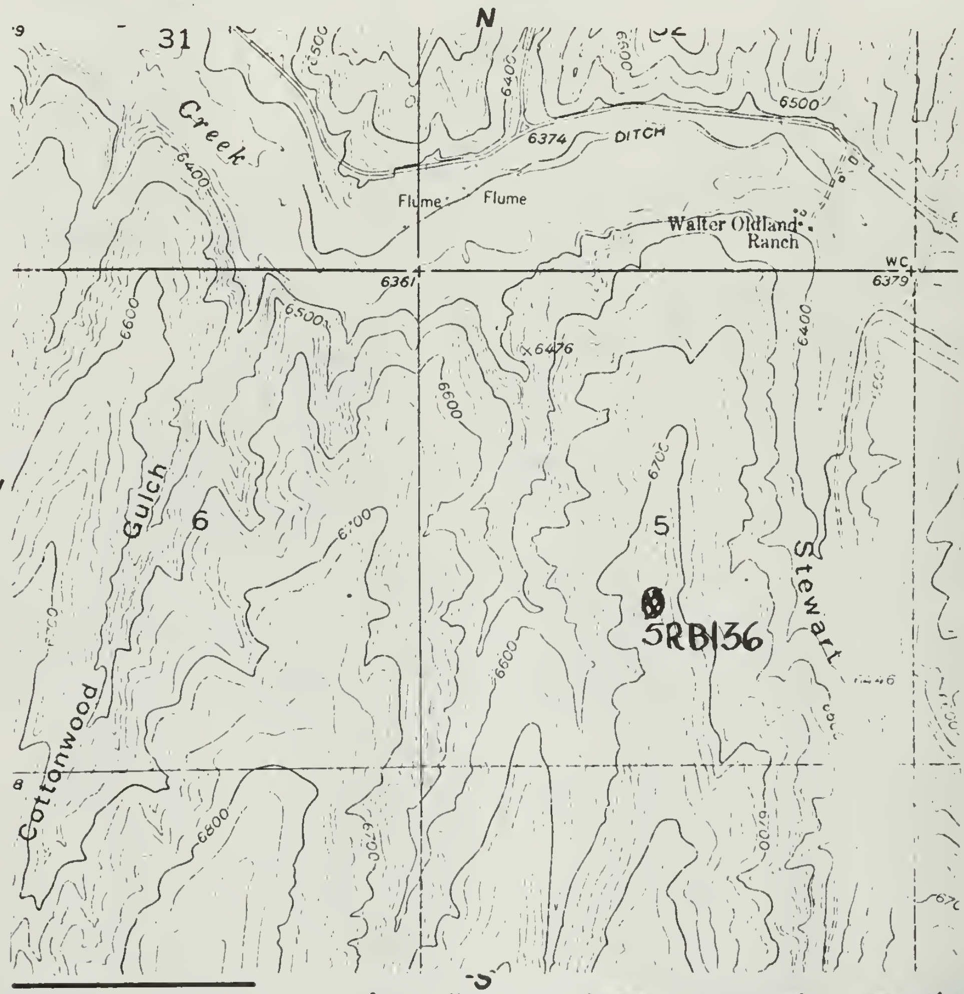
Site No. 5RB136, Rio Blanco County, Colo. State. Stewart Gulch Drainage. NE¼ SW¼ SEC. 5, T. 3S, R. 96W. Page 1 of 2

Sketch Map of Location

Site No. 5RB136

NE¼SW¼ Section 5, Township 3S, Range 96W

Indicate the chief topographic features, such as streams and elevations. Also indicate houses and roads. Enclose the site area with dotted line. If possible, show extent and kinds of vegetation and sources of other natural resources which may have influenced site selection. Attach a Xerox of portion of U.S.G.S. quadrangle map showing site location, if possible.



SCALE 1 block = (if diagram does not equal a section)

Directions to site: Turn off Piceance Creek Road at Willow Creek access road (18.8 mi. northwest of Rio Blanco). Take Cb tract access on south side of Stay left at the first two junctions on the tract access road. Drive 5.3 mi from Piceance Creek Road to Core Hole 7 access road. Turn left (north) on to Core Hole 7 road and drive 2.65 mi. to barbed wire fence. Site is ca. 0.1 mi. further north along the truck trail and is concentrated on the right (east) side of the road.

ARCHAEOLOGICAL SURVEY OF COLORADO INVENTORY SHEET

Site No. 5RB146, Rio Blanco County, Colorado State White River-Piceance Creek-Stewart Gulch Drainage

1. Prior No./Name None Used By

2. Elevation 2066 m. 3. Jessup Gulch U.S.G.S. Quad 4 Other Map

5. **LOCATION** On ridgetop ca. 730 m. SW of confluence of Stewart Gulch and its West Fork and about 320 m. S of Core Hole Cb-3.

U.T.M. Grid 4,410,420 m. N 740,390 m. E

, SE¼SW¼ of SEC. 5 TOWNSHIP 3S, RANGE 96W

6. Owner Public Domain 7. Address

8. Tenant 9. Prior Owner(s)

10. Informant None 11. Address

12. **NEAREST WATER** Stewart Gulch permanent xxxx, season

13. Distance to 12 730 m. 14. Elevation of 12 1950 m.

15. **LOCALE VEGETATION** Pinyon, Juniper, sage, prickly pear, grasses

16. **SITE TYPE** Open chipping 17. Cultural Affiliation (if known)

18. Description Thin scatter of cultural material in area around quarter section monument. Much of the site area has been chained. No evidence of fire pits or other features.

19. Size Ca. 800 m^2 20. Faces to (cardinal direction) Northeast.

21. Depth & Character of Deposits Sandy soil with scattered fragments of sandstone. Depth indeterminate but there are no outcrops of the bedrock on the site.

22. Material Observed or Reported Waste flakes

23. Material Collected Waste flakes, two projectile points, scraper fragment.

24. Condition Partly destroyed by chaining of pinyon-juniper cover.

25. **RECOMMENDATIONS** Site should be protected where it remains undisturbed and should be test excavated if directly endangered by future development of the tract. The site should not be nominated to the National Register.

26. Photograph Nos. None 27. Recorded By D.A. Weber, A.P. McNamara

28 Date August 5, 1974

SEND TO — Office of the State Archaeologist
5-A Ketchum Hall
University of Colorado
Boulder, Colorado 80302

SEE REVERSE & CONTINUATION SHEET Nos.

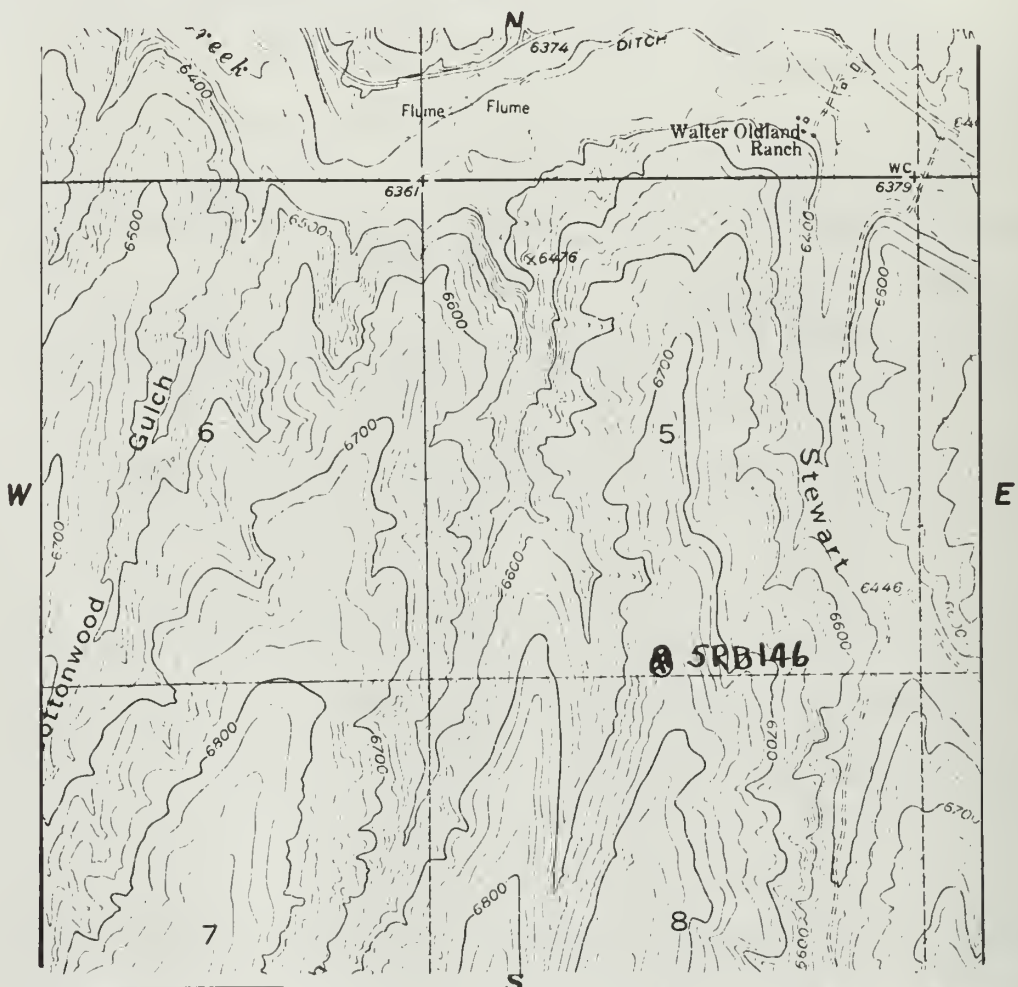
Site No. 5RB146, Rio Blanco County, Colo. State. Stewart Gl. Drainage. SE¼SW¼ SEC 5, T 3S, R. 96W. Page 1

Sketch Map of Location *Page 2*

Site No. 5RB146

SE¼SW¼ *Section* 5 *, Township* 3S *, Range* 96W .

Indicate the chief topographic features, such as streams and elevations. Also indicate houses and roads. Enclose the site area with dotted line. If possible, show extent and kinds of vegetation and sources of other natural resources which may have influenced site selection. Attach a Xerox of portion of U.S.G.S. quadrangle map showing site location, if possible.



SCALE 1 block = 2600' *(if diagram does not equal a section)*

Directions to site: Take Colorado Hwy. 13 & 789 to Rio Blanco, turn west on to Piceance Creek Road and drive 20.8 mi. to the Willow Creek and PL Ranch Road which is also the main access road to the Cb tract. Drive 0.3 mi. to first junction and stay left and continue ca. 4.1 mi. to SG-6 road; stay to right and drive another 1.4 mi. to SG-7 road and then turn left. Drive down SG-7 road ca. 1.9 mi. to boundary between Sec. 5 and 8. Site is located east of the road in the copse of trees and north in the chained area.

ARCHAEOLOGICAL SURVEY OF COLORADO INVENTORY SHEET

Site No 5RB147, Rio Blanco County, Colorado State White River, Piceance Cr., Willow Creek, Scandard Gulch Drainage

1· Prior No·/Name ______ Used By ______

2· Elevation 2006 m. 3· Jessup Gulch U·S·G·S· Quad 4· Other Map ______

5· **LOCATION** Southeast of Evacuation Creek s/s outcrop on ridge which is in turn southeast of the confluence of Willow Cr. and Scandard Gulch. .34 mi. south of (con't) SW¼SE¼ of SEC· 2 TOWNSHIP 3S, RANGE 97W
U·T·M· Grid 4,410,500 m N 736,880 m E

6· Owner Public Domain 7· Address ______

8· Tenant ______ 9· Prior Owner(s) ______

10· Informant ______ 11· Address ______

12· **NEAREST WATER** Willow Creek permanent XXX, season ______

13· Distance to 12 230 m 14· Elevation of 12 1954 m.

15· **LOCALE VEGETATION** Pinyon, juniper, sage, prickly pear, grasses

16· **SITE TYPE** Open Chipping 17· Cultural Affiliation (if known) ______

18· Description Scattered flakes at base of s/s outcrop which commands an excellent view of Willow Creek and the ridge east of Scandard Gulch. Chained trees have undoubtedly covered a good percentage of the site.

19· Size 21 m x 34 m. 20· Faces to (cardinal direction) Southeast

21· Depth & Character of Deposits Sandy residual material from weathered Evacuation Creek s/s. Depth may run to excess of 50 cm.

22· Material Observed or Reported Scattered flakes.

23· Material Collected 5 flakes, 1 fragment of biface of blac chert

24· Condition Path used by livestock crosses site and it has been chained over much of its area.

25· **RECOMMENDATIONS** Test in undisturbed areas if site is endangered. Site should not be nominated to National Register.

26· Photograph Nos· None 27· Recorded By Donna C. Daniels, Morris Anderson.

28 Date 8/7/74

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5-A Ketchum Hall
University of Colorado
Boulder, Colorado 80302

SEE REVERSE & CONTINUATION SHEET Nos· 1

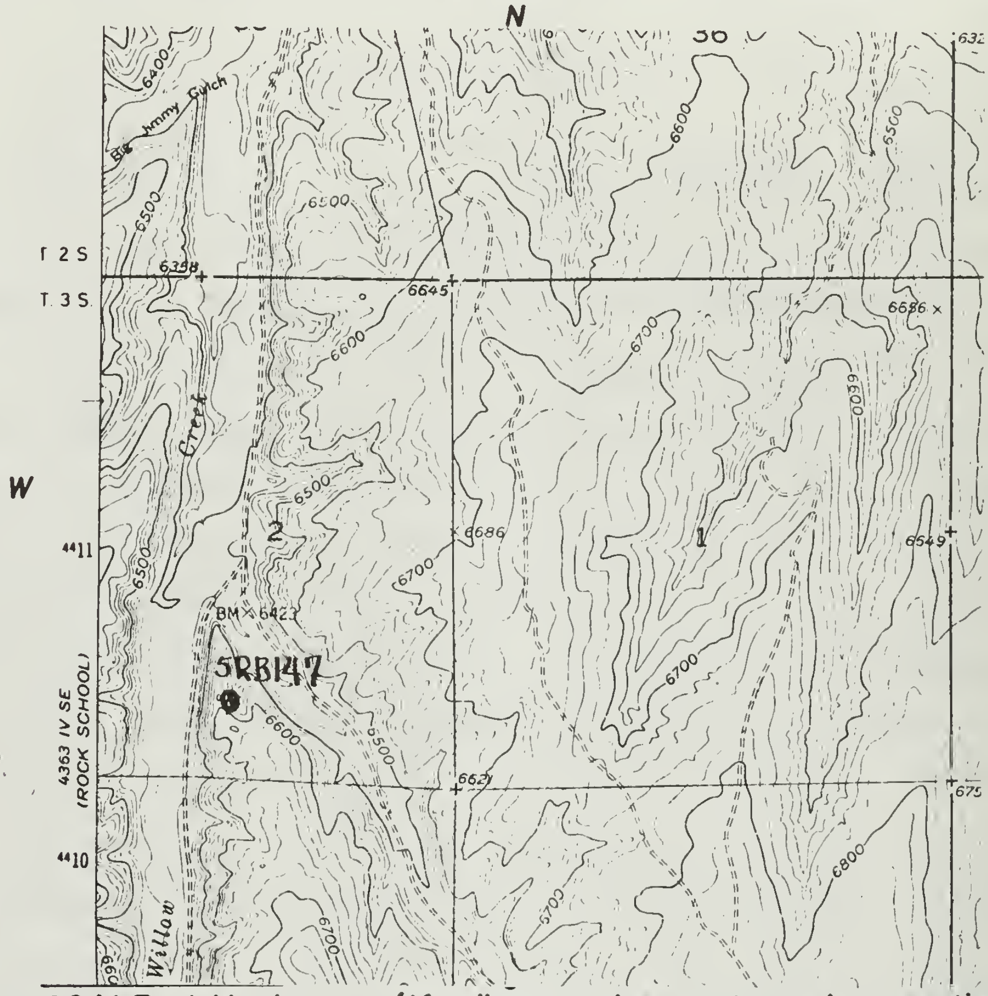
Site No 5RB147, Rio Blanco County, Colo. State· Scandard Gl. Drainage SW¼SE¼ SEC 2, T 3S, R 97W · Page 1 of 3

Sketch Map of Location

Site No. 5RB147

SW¼SE¼ Section 2, Township 3S, Range 97W

Indicate the chief topographic features, such as streams and elevations. Also indicate houses and roads. Enclose the site area with dotted line. If possible, show extent and kinds of vegetation and sources of other natural resources which may have influenced site selection. Attach a Xerox of portion of U.S.G.S. quadrangle map showing site location, if possible.



SCALE / block = (if diagram does not equal a section)

Directions to site : From Rio Blanco go northwest on Piceance Creek Road 18.8 miles. Turn right on the PL Ranch road and travel 0.5 mi. south, take west (right) fork and travel another 0.3 mi. to PL Ranch buildings and turn to south (left). Go 1.3 mi. south to intersection of Willow Creek and Scandard Gulch roads. The site is atop the ridge which faces into the confluence of the two drainages.

ARCHAEOLOGICAL SURVEY OF COLORADO CONTINUATION SHEET

Site No. 5RB147

ITEM No.	COMMENT
5	the intersection of the Scandard Gulch and the Willow Creek roads.

Site No. 5RB147 1st CONTINUATION SHEET.

Recorded by D.C. Daniels, M.R. Anderson

Date 8/7/74

SEE REVERSE

Appendix B

CATALOG FORMS

COLORADO STATE UNIVERSITY

Archaeology Catalog: Site/Isolated Find

(1) Cat. No. 5 - RB - 67 . 1 (2) Cat. Name Metal

(3) Project/Source Z.P.B. 1973 (4) Analytical Name ____ By ____

(5) Field Spec. No. ____ Date ____ (6) Cat. By RWL Date 1/7/74

(7) Owner N/A

Name Address City State Zip

(8) No. of Pieces 1 (9) Pres. Storage CSU Arch. Lab.

(10) Provenience: Horizontal T3S S.16 SESW R96W Vertical Surface

(11) Stratigraphic Association(s): None

(12) Condition Rusted (13) Preservatives None

(14) Photo Cat. No. ____ (15) Pub. Illust. No. ____

(16) Pub. Reference ____

(17) Misc. Remarks Beer can. Some markings present. Capped can. "Country Club".

(18) Description: L = ____ cms. W = ____ cms. T/H = ____ cms.

Max. Diam. = ____ cms. Min. Diam. = ____ cms.

Material(s) Metal

Technique(s) of manufacture Industrial

(19) Sketch (use back if necessary): (20) Scale of drawing 1:1

COLORADO STATE UNIVERSITY

Archaeology Catalog: Site/Isolated Find

(1) Cat. No. 5 - RB - 67 . 2

(2) Cat. Name Metal

(3) Project/Source P.B. 1973

(4) Analytical Name ______ By ______

(5) Field Spec. No. ______ Date ______

(6) Cat. By RWL Date 1/7/74

(7) Owner N/A

Name Address City State Zip

(8) No. of Pieces 1

(9) Pres. Storage CSU Arch. Lab.

(10) Provenience: Horizontal T3S R96W S.16 SESW Vertical Surface

(11) Stratigraphic Association(s): None

(12) Condition Rusted

(13) Preservatives None

(14) Photo Cat. No. ______

(15) Pub. Illust. No. ______

(16) Pub. Reference ______

(17) Misc. Remarks "Budweis--" Lager B---". Beer Can. rimmed at both ends.

(18) Description: L = ____ cms. W = ____ cms. T/H = ____ cms.

Max. Diam. = ____ cms. Min. Diam. = ____ cms.

Material(s) Metal

Technique(s) of manufacture Industrial

(19) Sketch (use back if necessary):

(20) Scale of drawing 1:1

COLORADO STATE UNIVERSITY

Archaeology Catalog: Site/Isolated Find

(1) Cat. No. 5 - RB - 67 . 3 (2) Cat. Name Metal

(3) Project/Source P.B. 1973 (4) Analytical Name ____ By ____

(5) Field Spec. No. ____ Date ____ (6) Cat. By RWL Date 1/7/74

(7) Owner N/A

Name Address City State Zip

(8) No. of Pieces 1 (9) Pres. Storage CSU Arch. Lab.

(10) Provenience: Horizontal T3S R96W S.16 SESW Vertical Surface

(11) Stratigraphic Association(s): None

(12) Condition Rusted (13) Preservatives None

(14) Photo Cat. No. ____ (15) Pub. Illust. No. ____

(16) Pub. Reference ____

(17) Misc. Remarks Might be a carnation milk can.

(18) Description: L = ____ cms. W = ____ cms. T/H = ____ cms.

Max. Diam. = ____ cms. Min. Diam. = ____ cms.

Material(s) Metal

Technique(s) of manufacture Industrial

(19) Sketch (use back if necessary): (20) Scale of drawing 1:1

COLORADO STATE UNIVERSITY

Archaeology Catalog: Site/Isolated Find

(1) Cat. No. 5 - RB - 67 . 4 (2) Cat. Name Metal

(3) Project/Source P.B. 1973 (4) Analytical Name ____ By ____

(5) Field Spec. No. ____ Date ____ (6) Cat. By RWL Date 1/7/74

(7) Owner N/A
Name Address City State Zip

(8) No. of Pieces 1 (9) Pres. Storage CSU Arch. Lab.

(10) Provenience: Horizontal T3S R96W S.16 SESW Vertical Surface

(11) Stratigraphic Association(s): None

(12) Condition Rusted (13) Preservatives None

(14) Photo Cat. No. ____ (15) Pub. Illust. No. ____

(16) Pub. Reference ____

(17) Misc. Remarks "Country Club"-- beer can. Capped and identical to 5RB67.1.

(18) Description: L = ____ cms. W = ____ cms. T/H = ____ cms.

Max. Diam. = ____ cms. Min. Diam. = ____ cms.

Material(s) Metal

Technique(s) of manufacture Industrial

(19) Sketch (use back if necessary): (20) Scale of drawing 1:1

COLORADO STATE UNIVERSITY

Archaeology Catalog: Site/Isolated Find

(1) Cat. No. 5 - RB - 69 . 1 (2) Cat. Name Non-indigenous cobble

(3) Project/Source P.B. 1973 (4) Analytical Name ______ By ______

(5) Field Spec. No. ______ Date ______ (6) Cat. By R.W.L. Date 11/16/73

(7) Owner N/A
Name Address City State Zip

(8) No. of Pieces 1 (9) Pres. Storage CSU Arch. Lab

(10) Provenience: Horizontal T2S R97W S.36 NWNW Vertical Surface

(11) Stratigraphic Association(s): None

(12) Condition Complete (13) Preservatives None

(14) Photo Cat. No. ______ (15) Pub. Illust. No. ______

(16) Pub. Reference ______

(17) Misc. Remarks Roughly circular in shape and exotic.

(18) Description: L = n/a cms. W = N/A cms. T/H = N/A cms.

Max. Diam. = 11.75 cms. Min. Diam. = 10.72 cms.

Material(s) Reddish-brown sandstone

Technique(s) of manufacture Natural

(19) Sketch (use back if necessary): (20) Scale of drawing 1:1

(over)

COLORADO STATE UNIVERSITY

Archaeology Catalog: Site/Isolated Find

(1) Cat. No. 5 RB - 69 . 2 (2) Cat. Name Exotic river cobble

(3) Project/Source P.B. 1973 (4) Analytical Name ______ By ______

(5) Field Spec. No. ______ Date ______ (6) Cat. By R.W.L. Date 11/16/73

(7) Owner N/A

Name Address City State Zip

(8) No. of Pieces 1 (9) Pres. Storage CSU Arch. Lab.

(10) Provenience: Horizontal T2S R97W S.36 NWNW Vertical Surface

(11) Stratigraphic Association(s): None

(12) Condition Complete (13) Preservatives None

(14) Photo Cat. No. ______ (15) Pub. Illust. No. ______

(16) Pub. Reference ______

(17) Misc. Remarks Exotic river cobble.

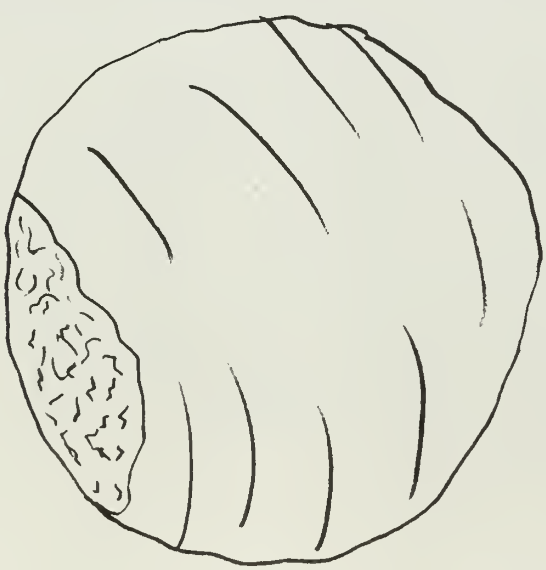
(18) Description: L = N/A cms. W = N/A cms. T/H = 4.51 cms.

Max. Diam. = 7.42 cms. Min. Diam. = 7.40 cms.

Material(s) Tan quartzite

Technique(s) of manufacture Natural

(19) Sketch (use back if necessary): (20) Scale of drawing 1:1



COLORADO STATE UNIVERSITY

Archaeology Catalog: Site/Isolated Find

(1) Cat. No. 5 -RB -136 . 1   (2) Cat. Name Biface Frag.

(3) Project/Source 74-4(CHJ)   (4) Analytical Name ______ By ______

(5) Field Spec. No. N/A Date ______   (6) Cat. By CHJ Date 12/27/74

(7) Owner Public Domain
Name Address City State Zip

(8) No. of Pieces 1   (9) Pres. Storage CSU-LOPA

(10) Provenience: Horizontal T3S, R96W, NW¼SE¼, S.5 Vertical General Surface

(11) Stratigraphic Association(s): None

(12) Condition Broken: Tip missing   (13) Preservatives None

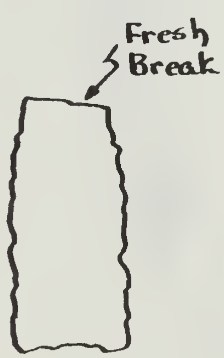
(14) Photo Cat. No. ______   (15) Pub. Illust. No. ______

(16) Pub. Reference ______

(17) Misc. Remarks Found in the immediate vicinity of 5RB136 and assigned to that site by CHJ. Listed as IF-CHJ-8-5-2 in DAW and APM notes.

(18) Description: L = 3.37 cms** W = 1.60 cms. T/H = 0.70 cms. **Broken in this dimension.
Max. Diam. = N /A cms. Min. Diam. = N/A cms.
Material(s) Mottled brown and black chert.
Technique(s) of manufacture Prob. only percussion flaking. No edge grinding.

(19) Sketch (use back if necessary):   (20) Scale of drawing 1:1



COLORADO STATE UNIVERSITY

Archaeology Catalog: Site/Isolated Find

(1) Cat. No. 5 - RB - 146 . 1 (2) Cat. Name Projectile Point

(3) Project/Source 74-4(CHJ) (4) Analytical Name ______ By ______

(5) Field Spec. No. N/A Date ______ (6) Cat. By CHJ Date 12/27/74

(7) Owner Public Domain
Name Address City State Zip

(8) No. of Pieces 1 (9) Pres. Storage CSU-LOPA

(10) Provenience: Horizontal T3S, R96W, SW¼SE¼, S.5 Vertical General Surface

(11) Stratigraphic Association(s): None

(12) Condition Tip, both tangs, 1 corner broken. (13) Preservatives None

(14) Photo Cat. No. ______ (15) Pub. Illust. No. ______

(16) Pub. Reference ______

(17) Misc. Remarks Originally recorded as CHJ-IF-8-5-1 but later assigned to 5RB146 by CHJ. Triangular blade, straight edges, corner notched, slightly concave base, lighly serrated blade edges.

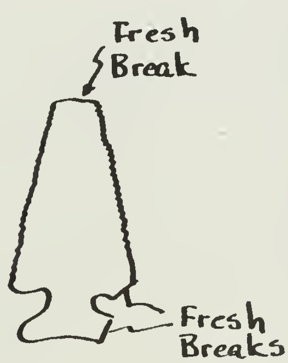
(18) Description: L = 3.27 cms.** W = 1.72 cms** T/H = 0.46 cms. **Broken in this dimension.

Max. Diam. = N/A cms. Min. Diam. = N/A cms.

Material(s) Gray chert

Technique(s) of manufacture Only pressure scars remain.

(19) Sketch (use back if necessary): (20) Scale of drawing 1:1



COLORADO STATE UNIVERSITY

Archaeology Catalog: Site/Isolated Find

(1) Cat. No. 5 - RB - 146 . 2 (2) Cat. Name Scraper

(3) Project/Source 74-4(CHJ) (4) Analytical Name ______ By ______

(5) Field Spec. No. N/A Date ______ (6) Cat. By CHJ Date 12/27/74

(7) Owner Public Domain

Name Address City State Zip

(8) No. of Pieces 1 (9) Pres. Storage CSU-LOPA

(10) Provenience: Horizontal T3S,R96W,SW¼SE¼, S. 5 Vertical General Surface

(11) Stratigraphic Association(s): None

(12) Condition Broken (13) Preservatives None

(14) Photo Cat. No. None (15) Pub. Illust. No. None

(16) Pub. Reference ______

(17) Misc. Remarks Originally collected as CHJ IF-5-1 by DAW, APM, & JLP. Assigned to 5RB146 by CHJ. Unifacially retouched on one margin. Cortex present on edge opposite retouching. Bulb or percussion and other landmarks missing.

(18) Description: L = 1.60 cms** W = 1.28 cms** T/H = 0.43 cms.** ** Broken in this dimension,

Max. Diam. = N/A cms. Min. Diam. = N /A cms.

Material(s) Jasper

Technique(s) of manufacture Pressure retouch (?)

(19) Sketch (use back if necessary): (20) Scale of drawing 1:1

COLORADO STATE UNIVERSITY

Archaeology Catalog: Site/Isolated Find

(1) Cat. No. 5 - RB - 146 . 3 (2) Cat. Name Projectile Point

(3) Project/Source 74-4(CHJ) (4) Analytical Name ______ By ______

(5) Field Spec. No. N/A Date ______ (6) Cat. By CHJ Date 12/27/74

(7) Owner Public Domain
Name Address City State Zip

(8) No. of Pieces 1 (9) Pres. Storage CSU-LOPA

(10) Provenience: Horizontal T3S, R96W, NE¼NW¼, S. 8 Vertical General Surface

(11) Stratigraphic Association(s): None

(12) Condition Broken: Stem and base missing (13) Preservatives None

(14) Photo Cat. No. ______ (15) Pub. Illust. No. ______

(16) Pub. Reference ______

(17) Misc. Remarks Originally recorded at CHJ IF-8-3-2 in DCD notes. Found on opposite side of pinyon-juniper stand from 5RB146.1 and .2 and south of ¼ sect. monument. Triangular blade with one straight and one convex margin. Both edges lightly serrated. Corner notched but basal form cannot be determined.

(18) Description: L = 2.16 cms** W = 1.53 cms. T/H = 0.26 cms. **Broken in this dimension.

Max. Diam. = N/A cms. Min. Diam. = N/A cms.

Material(s) Brown mottled chert.

Technique(s) of manufacture Only pressure scars remain.

(19) Sketch (use back if necessary): (20) Scale of drawing 1:1

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Archaeology Catalog: Site/Isolated Find

(1) Cat. No. XX - XX - IF . 112 (2) Cat. Name Projectile Point

(3) Project/Source 74-4 (CHJ) (4) Analytical Name ____ By ____

(5) Field Spec. No. N/A Date ____ (6) Cat. By CHJ Date 12/27/74

(7) Owner Public Domain

Name Address City State Zip

(8) No. of Pieces 1 (9) Pres. Storage CSU - LOPA

(10) Provenience: Horizontal T3S, R96W, NW$\frac{1}{4}$SE$\frac{1}{4}$, S. 7 Vertical General Surface

(11) Stratigraphic Association(s): None

(12) Condition Broken: Extreme portion of tip missing (13) Preservatives None

(14) Photo Cat. No. ____ (15) Pub. Illust. No. ____

(16) Pub. Reference ____

(17) Misc. Remarks Found in NE$\frac{1}{4}$NW$\frac{1}{4}$NW$\frac{1}{4}$SE$\frac{1}{4}$ of Section 7. Originally recorded as CHJ IF-8-4-1. Found by CHJ, KGP, DCD, APM. Triangular blade with slightly convex margins and no serration. Broad corner notches, convex base. Probably missing less than 2 mm. from total length.

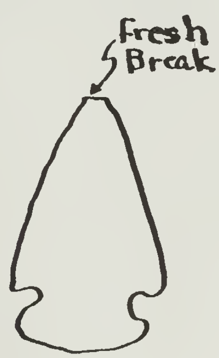
(18) Description: L = 3.48 cms.** W = 2.07 cms. T/H = 0.43 cms. **Broken in this dimension.

Max. Diam. = N/A cms. Min. Diam. = N/A cms.

Material(s) Gray chert with band of buff on one tang and corner. Buff is mottled with gray.

Technique(s) of manufacture Mix of pressure and percussion scars. One deep scar on one face on base.

(19) Sketch (use back if necessary): (20) Scale of drawing 1:1



COLORADO STATE UNIVERSITY

Archaeology Catalog: Site/Isolated Find

(1) Cat. No. XX - XX - IF . 113 (2) Cat. Name Projectile Point

(3) Project/Source 74-4(CHJ) (4) Analytical Name ______ By ______

(5) Field Spec. No. None Date ______ (6) Cat. By CHJ Date 12/27/74

(7) Owner Public Domain
Name Address City State Zip

(8) No. of Pieces 1 (9) Pres. Storage CSU - LOPA

(10) Provenience: Horizontal T3S, R96W, NW¼SE¼, S.18 Vertical General Surface

(11) Stratigraphic Association(s): None

(12) Condition Broken: Tip of one tang missing (13) Preservatives None

(14) Photo Cat. No. ______ (15) Pub. Illust. No. ______

(16) Pub. Reference ______

(17) Misc. Remarks Originally recorded as GAB IF-8-3-1. Found in SW¼SW¼NW¼SE¼ of Sec. 18. Triangular blade, straight margins, no serration. Broad, shallow corner notches; convex base with assymetrically placed notch (accidental?). Basal thinning. Probably not more than 3 mm. missing from width.

(18) Description: L = 3.55 cms. W = 2.52 cms** T/H = 0.67 cms. **Broken in this dimension.

Max. Diam. = N/A cms. Min. Diam. = N /A cms.

Material(s) Gray-green fine-grained quartzite.

Technique(s) of manufacture Mix of percussion and pressure scars. One face has three long, narrow basal thinning scars. The obverse has only one which ends in a right angle step fracture.

(19) Sketch (use back if necessary): (20) Scale of drawing 1:1

COLORADO STATE UNIVERSITY

Archaeology Catalog: Site/Isolated Find

(1) Cat. No. XX - XX - IF · 114 (2) Cat. Name Core

(3) Project/Source 74-4(CHJ) (4) Analytical Name ______ By ______

(5) Field Spec. No. N/A Date ______ (6) Cat. By CHJ Date 12/27/74

(7) Owner Public Domain
Name Address City State Zip

(8) No. of Pieces 1 (9) Pres. Storage CSU - LOPA

(10) Provenience: Horizontal T3S,R97W,SE¼SE¼, S. 2 Vertical General Surface

(11) Stratigraphic Association(s): None

(12) Condition Complete (?) (13) Preservatives None

(14) Photo Cat. No. None (15) Pub. Illust. No. None

(16) Pub. Reference ______

(17) Misc. Remarks Originally recorded as DCD IF-8-7-2. Found in NE¼NE¼SE¼SE¼ of Sec. 2. Fragment of river cobble which has had at least three large, thick flakes removed from it. No evidence of use as any thing but a core.

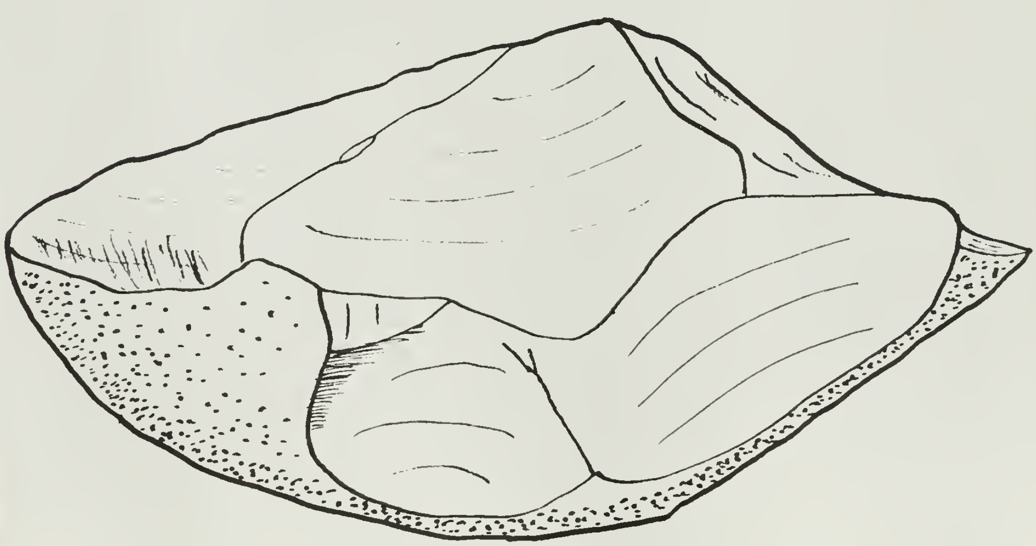
(18) Description: L = 13.8 cms. W = 6.4 cms. T/H = 4.7 cms.

Max. Diam. = N/A cms. Min. Diam. = N/A cms.

Material(s) Mottled and banded gray and brown quartzite.

Technique(s) of manufacture Percussion chipping

(19) Sketch (use back if necessary): (20) Scale of drawing 1:1



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Archaeology Catalog: Site/Isolated Find

(1) Cat. No. XX - XX - IF . 115 (2) Cat. Name Mano

(3) Project/Source 74-4(CHJ) (4) Analytical Name ____ By ____

(5) Field Spec. No. N/A Date ____ (6) Cat. By CHJ Date 12/27/74

(7) Owner Public Domain
Name Address City State Zip

(8) No. of Pieces 1 (9) Pres. Storage CSU-LOPA

(10) Provenience: Horizontal T3S,R97W, NW$\frac{1}{4}$SE$\frac{1}{4}$, S. 11 Vertical General Sufvace

(11) Stratigraphic Association(s): None

(12) Condition Complete (13) Preservatives None

(14) Photo Cat. No. None (15) Pub. Illust. No. ____

(16) Pub. Reference ____

(17) Misc. Remarks Originally recorded as WIB IF-8-8-2. Sub-rectangular prepared tool. Bifacially polished; one face smooth, the other pecked. Grinding facets perpendicular to the plane of the two faces appear on either end.

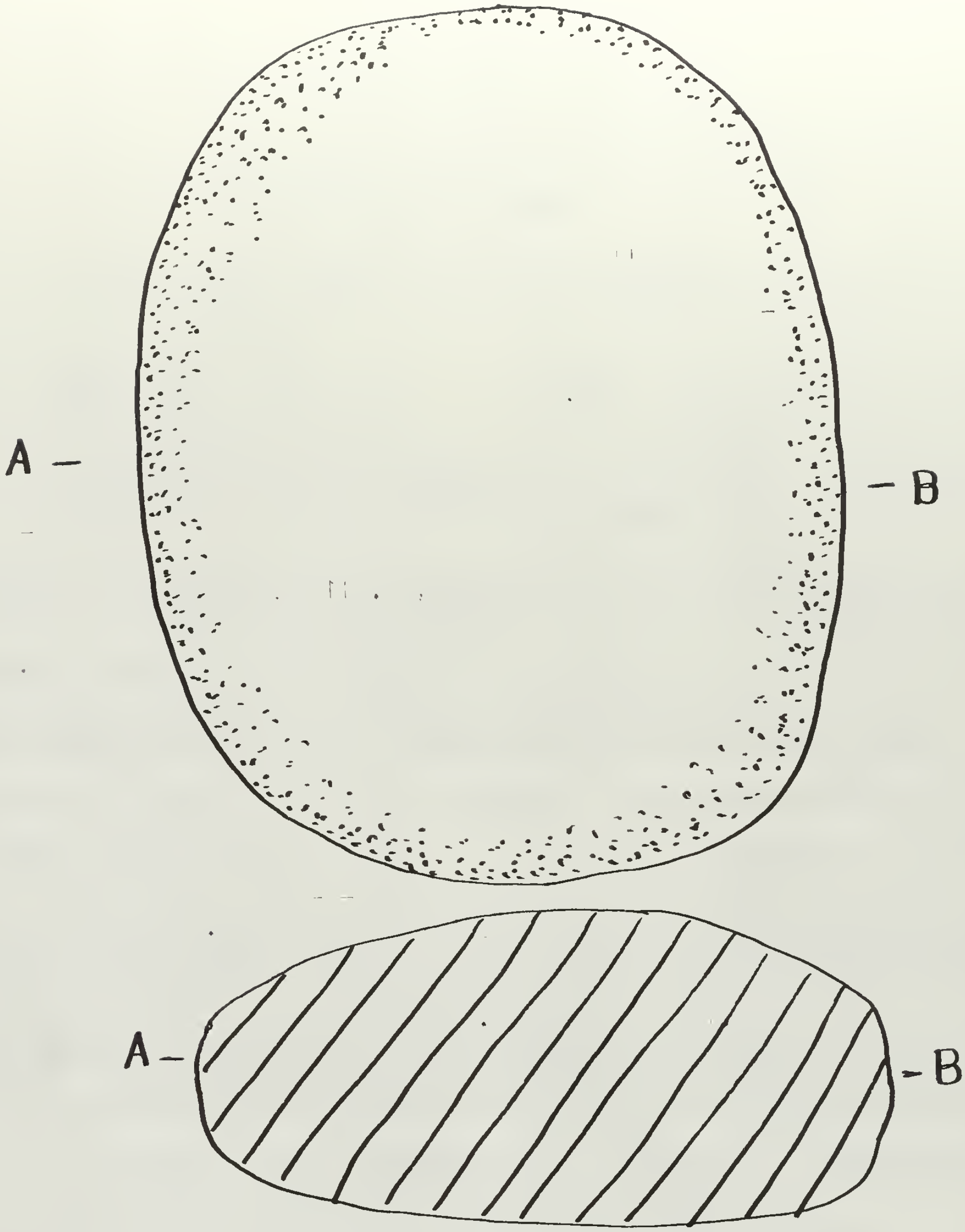
(18) Description: L = 12.1 cms. W = 9.8 cms. T/H = 4.4 cms.

Max. Diam. = N/A cms. Min. Diam. = N/A cms.

Material(s) Brown and buff banded medium grained quartzite.

Technique(s) of manufacture Pecking and polishing

(19) Sketch (use back if necessary): (over) (20) Scale of drawing 1:1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COLORADO STATE UNIVERSITY

Archaeology Catalog: Site/Isolated Find

(1) Cat. No. XX - XX - IF . 116 (2) Cat. Name Mano

(3) Project/Source 74-4(CHJ) (4) Analytical Name ______ By ______

(5) Field Spec. No. N/A Date ______ (6) Cat. By CHJ Date 12/27/74

(7) Owner Public Domain

Name Address City State Zip

(8) No. of Pieces 1 (9) Pres. Storage CSU - LOPA

(10) Provenience: Horizontal T3S, R96W, NW¼SW¼, S. 19 Vertical General Surface

(11) Stratigraphic Association(s): None

(12) Condition Complete (13) Preservatives None

(14) Photo Cat. No. None (15) Pub. Illust. No. ______

(16) Pub. Reference ______

(17) Misc. Remarks Originally recorded as CLH IF-8-4-1. Sub-rectangular prepared tool with only one working face. Grinding facets perpendicular to the plane of the working face are presnnt at either end. Deep use caused striae are present on the working face.

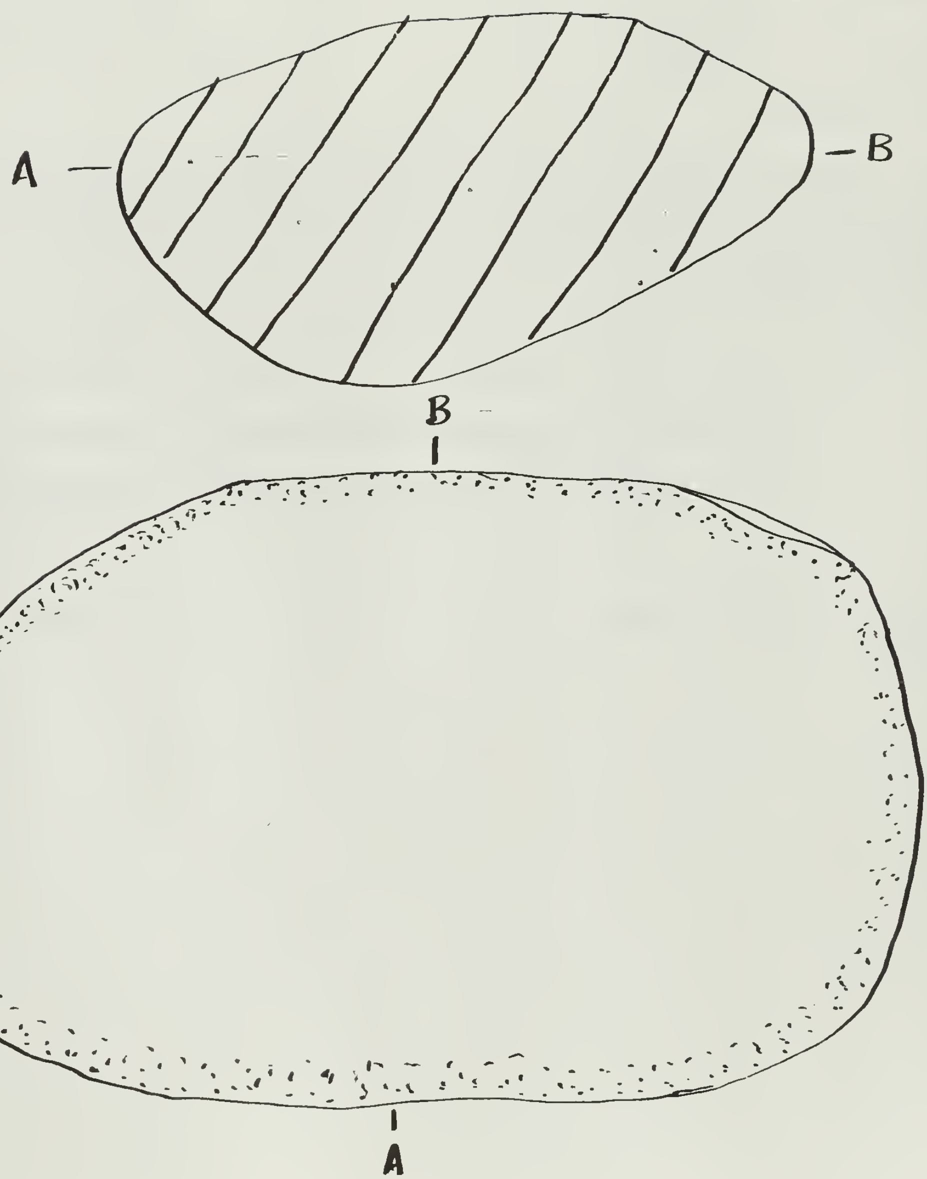
(18) Description: L = 13.4 cms. W = 8.8 cms. T/H = 5.4 cms.

Max. Diam. = N/A cms. Min. Diam. = N/A cms.

Material(s) Red-brown medium grained quartzite

Technique(s) of manufacture Pecking and polishing

(19) Sketch (use back if necessary): (over) (20) Scale of drawing 1:1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Archaeology Catalog: Site/Isolated Find

(1) Cat. No. XX - XX - IF . 117 (2) Cat. Name Biface

(3) Project/Source 74--7 (CHJ) (4) Analytical Name ______ By ______

(5) Field Spec. No. N/A Date ______ (6) Cat. By CHJ Date 12/27/74

(7) Owner Public Domain
Name Address City State Zip

(8) No. of Pieces 1 (9) Pres. Storage CSU - LOPA

(10) Provenience: Horizontal T2S, R96W, SE¼SE¼, S.31 Vertical General Surface

(11) Stratigraphic Association(s): None

(12) Condition Fragmentary (13) Preservatives None

(14) Photo Cat. No. None (15) Pub. Illust. No. None

(16) Pub. Reference ______

(17) Misc. Remarks Found by Mr. Don Tait, ARCO. See correspondence dated 11/19/74. Object is too fragmentary to warrant further comment.

(18) Description: L = xx cms. W = xx cms. T/H = xx cms.

Max. Diam. = xx cms. Min. Diam. = xx cms.

Material(s) Dark brown chert

Technique(s) of manufacture Percussion scars only.

(19) Sketch (use back if necessary): (20) Scale of drawing None made.

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Archaeology Catalog: Site/Isolated Find

(1) Cat. No. XX - XX - IF . 118 (2) Cat. Name Mano

(3) Project/Source 74-7(CHJ) (4) Analytical Name ______ By ______

(5) Field Spec. No. N/A Date ______ (6) Cat. By CHJ Date 12/27/74

(7) Owner Public Domain
Name Address City State Zip

(8) No. of Pieces 1 (9) Pres. Storage CSU - LOPA

(10) Provenience: Horizontal Somewhere in T3S,R96W, NW¼SW¼, S. 5 Vertical General Surface

(11) Stratigraphic Association(s): None

(12) Condition Complete (13) Preservatives None

(14) Photo Cat. No. None (15) Pub. Illust. No. None

(16) Pub. Reference ______

(17) Misc. Remarks Found by Dr. Warren Keammerer (part of environmental study team?). Small oviod pebble with pronounced facets on the two faces. No evidence of intentional shapping or of pecking. Also, no signs of wear which could be unequivocally attributed to use. May simply be an exotic carried into the area but not used.

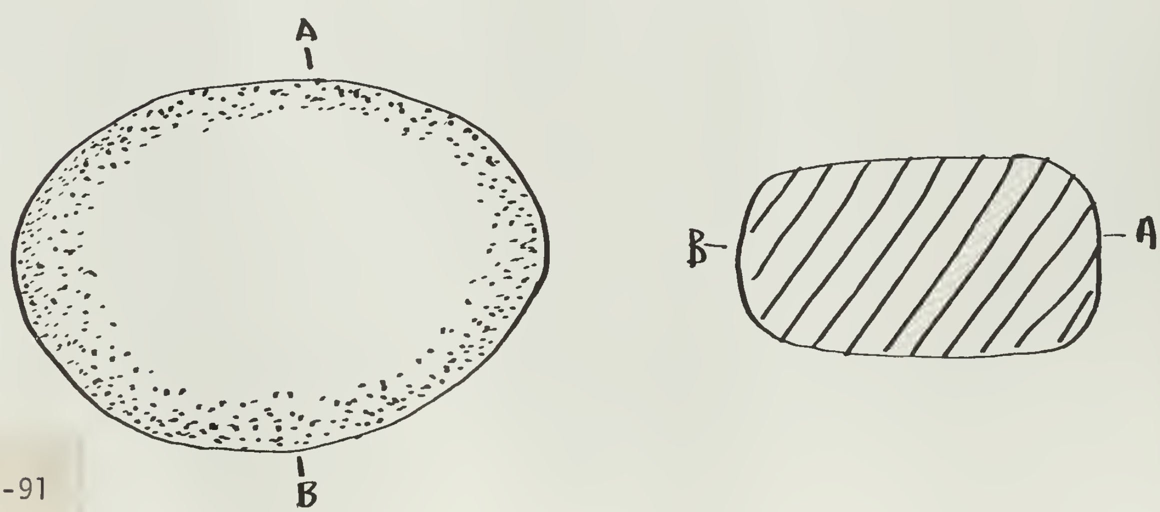
(18) Description: L = ~~XXX~~ cms. W = ~~XXX~~ cms. T/H = 3.2 cms.

Max. Diam. = 7.0 cms. Min. Diam. = 5.0 cms.

Material(s) Dark gray fine grained material, probably quartzite but heavy enough to perhaps be volcanic in origin.

Technique(s) of manufacture Polishing (?)

(19) Sketch (use back if necessary): (20) Scale of drawing 1:1



COLORADO STATE UNIVERSITY

Archaeology Catalog: Site/Isolated Find

(1) Cat. No. XX - XX - IF . 109 (2) Cat. Name Projectile Point

(3) Project/Source 74-4 (CHJ) (4) Analytical Name ____ By ____

(5) Field Spec. No. N/A Date ____ (6) Cat. By CHJ Date 12/27/74

(7) Owner Public Domain

Name Address City State Zip

(8) No. of Pieces 1 (9) Pres. Storage CSU-LOPA

(10) Provenience: Horizontal T3S, R96W, NW¼SE¼, S.17 Vertical General Surface

(11) Stratigraphic Association(s): None

(12) Condition Broken: Tip missing (13) Preservatives None

(14) Photo Cat. No. ____ (15) Pub. Illust. No. ____

(16) Pub. Reference ____

(17) Misc. Remarks Found near the main tract access road where it drops down the west wall of the West Fork of Stewart Gulch. Located in the SW¼NE¼NW¼SE¼ of Sec. 17. Triangular blade with slightly convex margins. Wide corner notches, stem only slightly expanding; convex base.

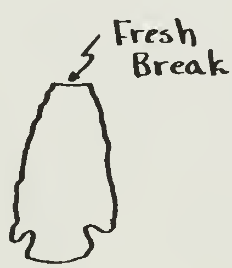
(18) Description: L = 2.41 cms** W = 1.44 cms. T/H = 0.37 cms. **Broken in this dimension.

Max. Diam. = N/A cms. Min. Diam. = N/A cms.

Material(s) Maroon chert

Technique(s) of manufacture Only pressure scars remain. No serration of blade margins.

(19) Sketch (use back if necessary): (20) Scale of drawing 1:1



COLORADO STATE UNIVERSITY

Archaeology Catalog: Site/Isolated Find

(1) Cat. No. XX - XX - IF . 110

(2) Cat. Name Biface

(3) Project/Source 74-4(CHJ)

(4) Analytical Name ____ By ____

(5) Field Spec. No. N/A Date ____

(6) Cat. By CHJ Date 12/27/74

(7) Owner Public Domain

Name | Address | City | State | Zip

(8) No. of Pieces 1

(9) Pres. Storage CSU-LOPA

(10) Provenience: Horizontal T3S,R97W, Sec. 25 Vertical General Surface

(11) Stratigraphic Association(s): None

(12) Condition ~~Fragmentary~~ Complete

(13) Preservatives None

(14) Photo Cat. No. None

(15) Pub. Illust. No. None

(16) Pub. Reference ____

(17) Misc. Remarks Originally recorded as DCD IF-8-7-1. Sub-triangular flake with light pressure retouch of one margin, both faces, from the striking platform to about ½ the distance to the distal end of the flake. Flake knife?

(18) Description: L = 3.45 cms. W = 2.03 cms. T/H = 0.55 cms.

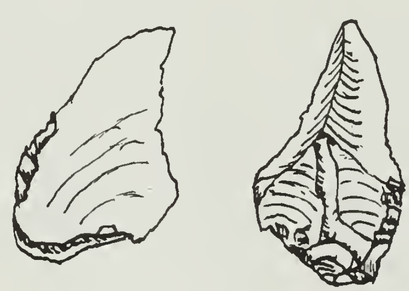
Max. Diam. = N/A cms. Min. Diam. = N/A cms.

Material(s) Gray/buff mottled chert. Very smooth texture, almost glassy.

Technique(s) of manufacture Marginal pressure retouch on waste flake.

(19) Sketch (use back if necessary):

(20) Scale of drawing 1:1



COLORADO STATE UNIVERSITY

Archaeology Catalog: Site/Isolated Find

(1) Cat. No. XX - XX - IF - 111   (2) Cat. Name Scraper

(3) Project/Source 74-4(CHJ)   (4) Analytical Name ____ By ____

(5) Field Spec. No. N /A Date ____   (6) Cat. By CHJ Date 12/27/74

(7) Owner Public Domain
Name   Address   City   State   Zip

(8) No. of Pieces 1   (9) Pres. Storage CSU-LOPA

(10) Provenience: Horizontal T3S,R97W, SE$\frac{1}{4}$NE$\frac{1}{4}$, S. 2 Vertical General Surface

(11) Stratigraphic Association(s): None

(12) Condition Fragmentary   (13) Preservatives None

(14) Photo Cat. No. None   (15) Pub. Illust. No. None

(16) Pub. Reference ____

(17) Misc. Remarks Found in SW$\frac{1}{4}$SE$\frac{1}{4}$SE$\frac{1}{4}$NE$\frac{1}{4}$ of Section 2. Flake is broken on long axis so that one lateral margin and part of both the priximal and distal margins are missing. Dorsal retouch of one remaining lateral margin and continues around to remaining portion of distal margin. Angle formed by longitudinal fracture and (over)

(18) Description: L = 5.76 cms. W = 1.79 cms** T/H = 0.82 cms. **Broken in this dimension.

Max. Diam. = N/A cms. Min. Diam. = N /A cms.

Material(s) Translucent brown chert. Quite glassy in texture.

Technique(s) of manufacture Pressure (?) retouch. Lateral margin has more acute working edge, distal margin steeper.

(19) Sketch (use back if necessary):   (20) Scale of drawing 1:1

distal margin has been retouched into a sharp point. The retouch continues up the lateral margin formed by the fracture for a short distance. The retouch is limited to the dorsal face. The ventral face at the point shows polish (from use?).

SCENIC VALUES PROGRAM

III G SCENIC VALUES PROGRAM

During the second quarter, photographic documentation (mainly 35 mm slides, some movie footage) continued on the Tract and surrounding area. This documentation is providing a record of baseline conditions which will be useful for the scenic values program. Stations have been marked at fixed locations for periodic photographs to show changes with time and season. The station sites include both overview and localized coverage.

Specific activities also are being photographed such as various environmental studies and exploration work in order to consider mitigation of potential impacts. Sites for these photographs are chosen on the basis of their position as focal points of continuing activity.

Several alternate approaches for more fully evaluating the aesthetic resources of the Tract area are being investigated. Approaches are being considered based on the applicability of the method to evaluating the characteristics of the Tract and its surrounding area, as well as the usefulness of the approach for input of the scenic values into the development phases of the project.